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INDUSTRIAL ENGINEERING

MAY-1930

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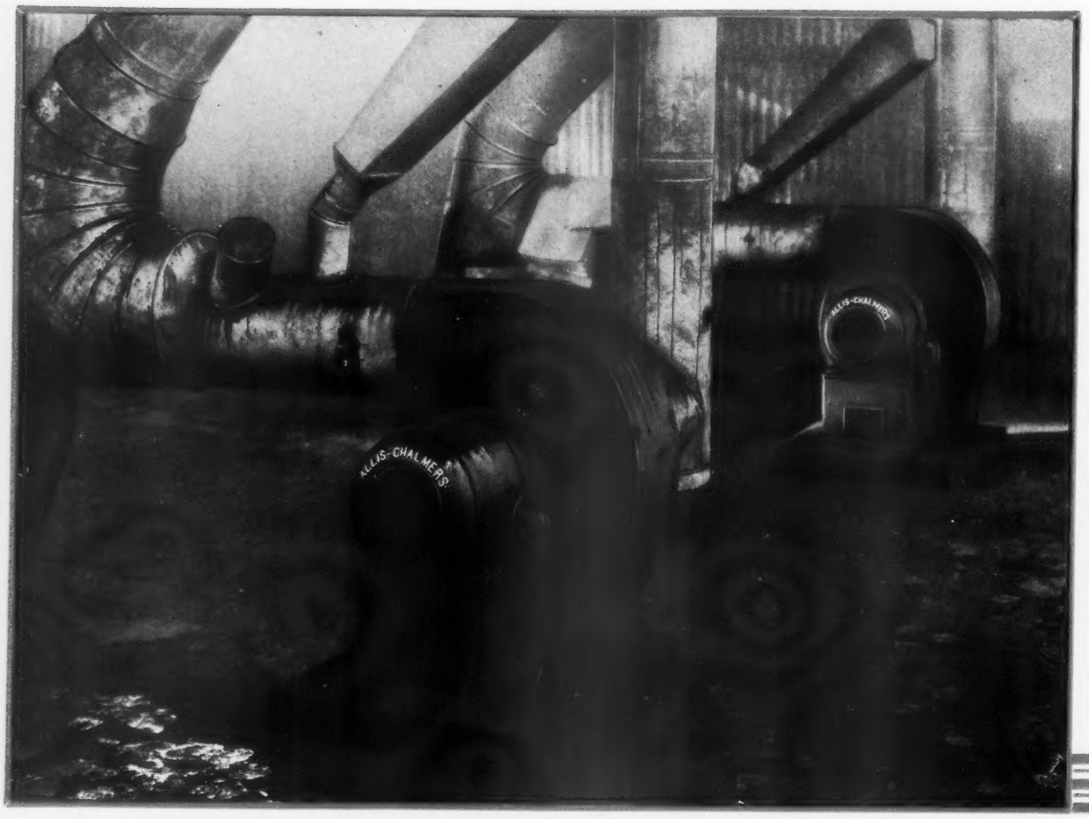

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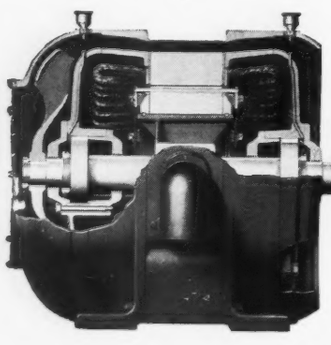

Allis-Chalmers Manufacturing Company
Milwaukee, Wisconsin

ALLIS-CHALMERS

Totally Enclosed Fan-cooled MOTORS

INDUSTRIAL ENGINEERING

Founded in 1882 as Electrical Review. Consolidated with it—Western Electrician and Industry Illustrated.

Engineering and Maintenance in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

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Editorial Contents for May, 1930

Your Window Glass 225
By H. S. JACOBY

Electric Furnaces 229
By C. L. HEISLER, JR.

Keeping Maintenance Abreast of Production 232
By H. R. WENTZELL

Plant Engineers' Forum 235

Mechanical Causes of Slip-Ring Troubles 239
By S. S. WOLFF

Editorials 242

Questions and Answers 245

What It Costs to Have a Clean Factory 248
By H. C. CHARLES

Power Drive Analysis—Conditions Unfavorable 249
By WILLIAM STANIAR

A Plant Engineer Looks at Maintenance 252
By C. H. WHITE

Around the Works 256

Checking Developed Winding Diagrams 260
By A. C. ROE

Highlights of the Mill Supplies Convention 263

Books 265

Industrial Engineering's Data Sheets 267

Equipment News and Trade Literature 269

Selecting factory window glass means more than just filling the sash—as you will find when you read what H. S. Jacoby has to say about it, starting on page 225.

Do you know how much it costs to keep your factory clean? If not, H. C. Charles has some interesting figures for you on page 248.

The title, "A Plant Engineer Looks at Maintenance," means just what it says—C. H. White, plant engineer, bases his opinions on practical experience gained within the plant—the article starts on page 252.

Highlights from the triple convention of mill supply groups, held in Memphis last month, begin on page 263.

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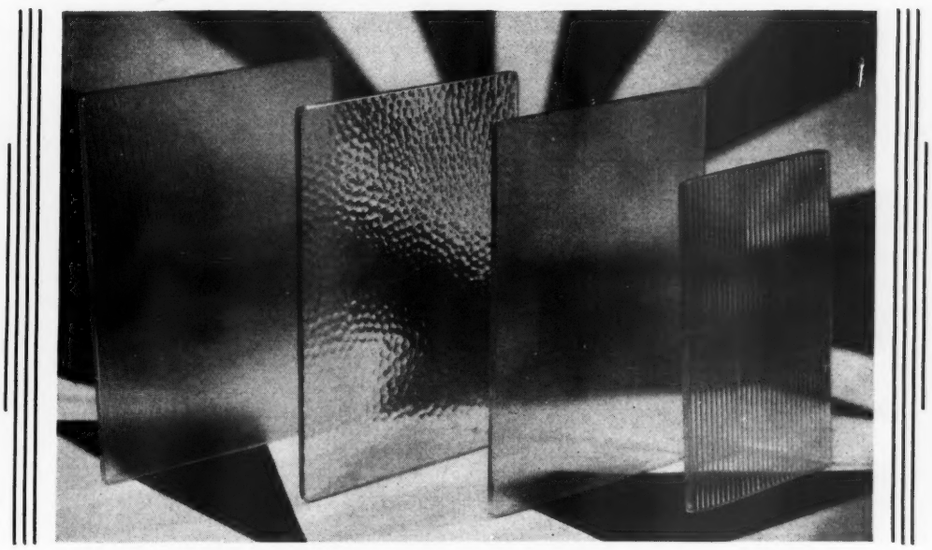


Your WINDOW GLASS

By H. S. JACOBY

Chief Engineer
The H. K. Ferguson Company
Cleveland, Ohio

EXPERIENCE has taught the manufacturer that abundant daylight not only reduces his electric light bill, but also improves the quantity and quality of his output by adding to the comfort, safety, and satisfaction of the workmen in his factory.

Demand for daylight illumination in recent years has caused much research and study on the subject. Conclusions from these studies have established the fact that, generally speaking, a minimum intensity of ten foot-candles provides sufficient illumination for most manufacturing operations.

All sunlight entering a building must pass through a common medium —glass. Even the slightest variation in the type of medium will modify the results.

It is the duty of the engineer who designs industrial buildings to provide sufficient window area and so to distribute it that the intensity of daylight within the building will not fall below the established minimum at any point. But, even with well-designed windows and monitors, unsatisfactory conditions may result from the use of an improper glazing medium.

There is, indeed, a great deal to be considered in selecting the proper type of window glass for a factory. Everything from the nature of the product to be manufactured in the building to the size of the structure itself must be taken into consideration.

The primary purpose of all glass, of course, is to permit the sun's rays to enter a building in such a manner that it will give maximum aid to the tools of production within.

In many buildings, particularly those with a very large floor area, it becomes necessary to diffuse the sunlight as it enters the building, in order to prevent it from concentrating too much in one spot. We have, however, built three plants for a manufacturer who desired daylight illumination with clear glass, al-

The illustration above shows four samples of figured surface glass; left to right, double scored, hammered, factory ribbed, one-way deep prismatic scoring.

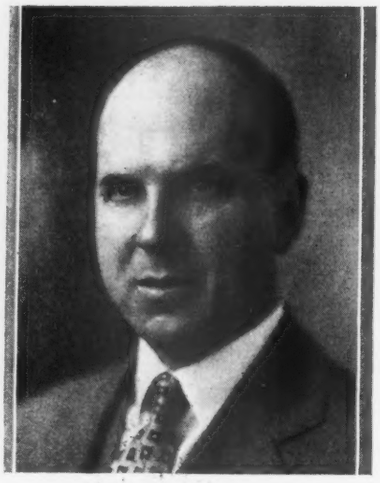
though he had a multi-story building with a large area on each floor. Ideal conditions were retained in this plant by limiting the width of the floor. Light from each side was reflected through the windows to the ceiling, thus maintaining uniform illumination across the comparatively narrow floor area.

Window shades often are used with clear glass with very satisfactory and effective results. Prof. H. H. Higbie, in a series of investigations, has demonstrated that Venetian blinds drawn up from the bottom of the window with slats adjusted at the proper angle will not only eliminate the glare of the light through the smooth glass in a horizontal line of vision, but will reflect the light upward to the ceiling. From there it may be diffused and reflected down to the working level. The upper portion of the sash through which most of the useful light is admitted remains uncovered. The light from the lower portion which either falls to the floor or causes discomfort to the workers from glare, is diffused by the shades and put to use. Prof. Higbie's experiments show that illumination at the center of the building is better with the lower panes covered in this manner than it is with the entire sash exposed. Shades are impractical, however, in buildings where there is a considerable amount of dust present in the air.

Smooth glass is often used to afford the workmen a view of the outside. Some manufacturers claim this to be a desirable feature and others prefer not to have it, contending that it distracts the attention of the workmen from their work. The National Cash Register Company, of Dayton, Ohio, has clear glass in practically all of its buildings. The late John H. Patterson, founder of the company, wanted his employees to be able to look out and see the beautifully landscaped grounds and surrounding hills. There is a cheerful atmosphere about the plant that is due in no small part to the view obtained from the windows. On the other hand, some manufacturers have secret processes of manufacture which require an obscure glass to prohibit a view of operations from the outside.

It is in response to the arguments against clear glass that the glass industry has developed figured surfaces which not only obscure the vision, but also diffuse the direct, glaring rays of light at locations near the windows and increase the illumination at points farther away.

Patterned surfaces are being used to a very large extent today. Surfaces are made in a variety of figures and designs, all of which serve effectively as a screen and a diffusing agent.



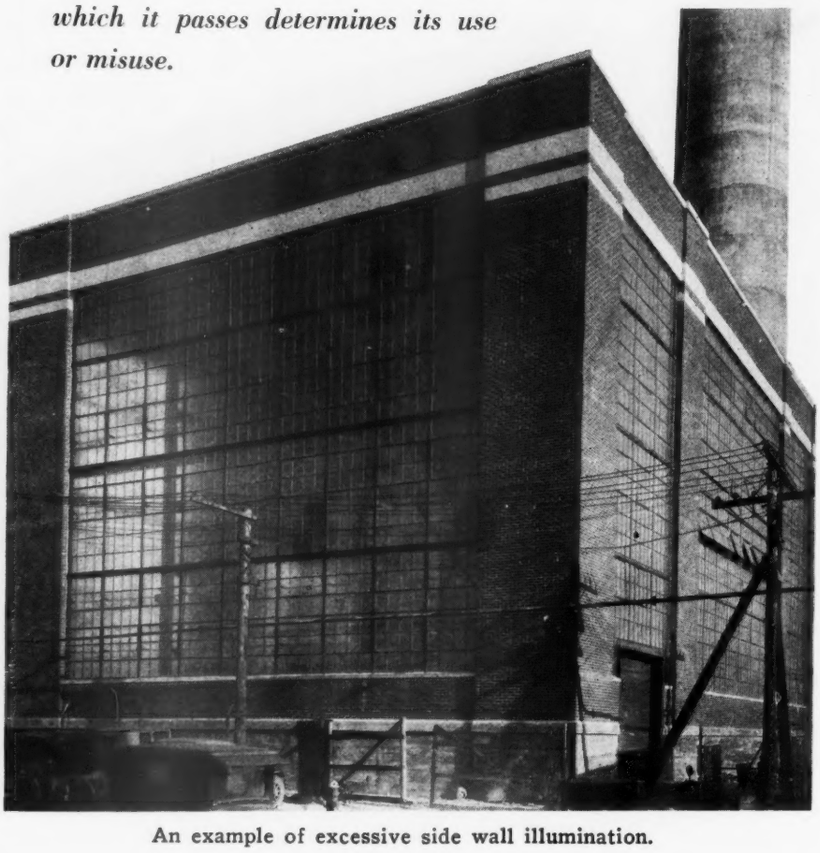
H. S. JACOBY

Daylight is nature's gift to industry. Misuse will impair efficiency. Proper use will improve every function of production. The glass through which it passes determines its use or misuse.

Factory ribbed glass, probably the best known obscuring glass, was almost universally used during the World War. Its surface consists of many small parallel ribs of prismatic form. This type of glass is usually installed with the ribs vertical. With the pattern in this position, the light is diffused through the small prisms in such a manner that it eliminates shadows usually caused by columns, mullions, pilasters, and other vertical obstructions.

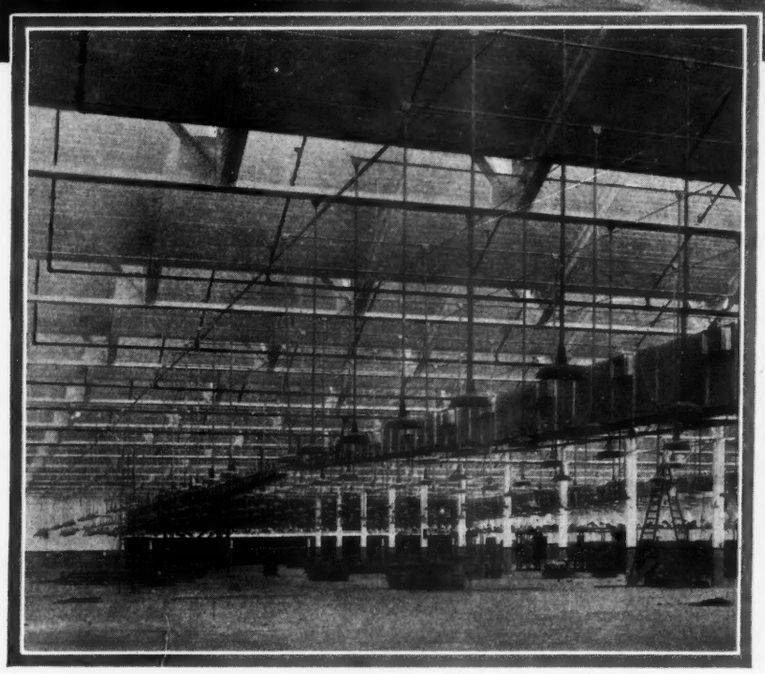
When the sun shines directly on this type of glass it becomes intensely luminous. Workmen facing it continuously complain of eyestrain caused by its glare.

Deeply scored prism glass is very similar to the factory ribbed type except that the scorings are deeper and the pattern larger. Its function is also similar but, due to the larger figure, the individual prisms stand out like alternating bands of light and dark. This type of glass is excellent for use in skylights. It diffuses the sunlight evenly over the floor area but, because of its location well above the horizontal line of vision, the objection of



An example of excessive side wall illumination.

Shades are used by this manufacturer to control light through clear glass in his side wall windows.



Large floor area uniformly daylighted with little or no side wall opening.

eyestrain is removed. An added feature is that the V-shaped grooves prevent condensation drip by conducting the moisture to the gutters.

Hammered glass is particularly suited for use in sidewall sash. Its surface consists of a series of irregular elevations giving a hammered appearance from which the name is derived. Although it has a figured surface, it is comparatively easy to clean. Its function is more nearly like that of smooth glass than the ribbed or deeply scored glass, for light shining directly on it will not cause severe glare. However, its diffusing qualities are sufficient for most requirements.

Many manufacturers seem to believe that, because they have selected a suitable glass for the daylight illumination of their manufacturing units, they need not consider its maintenance. They admit the importance of daylight illumination to their workmen; they admit the bearing each type of glass will have on their illumination; but they are often inclined to overlook the fact that accumulation of dirt on their windows defeats their plans.

Cleaning is by far the most important factor in the attempt to secure daylight illumination, for, no matter how well the distribution and glazing of sidewall sash or monitor sash is planned, the windows cannot function properly if they are not kept clean.

Recently, in a series of tests conducted by W. C. Randall and Allen J. Martin, well-known authorities on illumination, it was found that windows in a vertical position with six months' exposure to a dirty atmosphere have a transmission coefficient of only 0.436. This means that, placed vertically and not cleaned for six months, accumulation of dirt on the glass reduces its efficiency over half what it would be if the glass were clean. As the plane of the glass increases toward the horizontal, the accumulation of dirt will increase. These tests also demonstrate that dust and dirt gather two or three times as quickly on the inside of the building as on the outside.

It is obvious that, if efficient and maximum production is to be maintained or increased by a maximum of daylight illumination, a definite schedule of cleaning must be established. Furthermore, the inside of the windows should be cleaned twice to every cleaning outside.

The type of glass used is an important factor from the standpoint of cleanliness as well as in the consideration of its illumination and diffusing qualities. A test to discover the cleaning behavior of different types of glass was recently conducted by our own research department with the use of samples of several varieties of glass. At the time of the test, these samples had been exposed on the roof of a building for about six months, within a few hundred feet of a railroad. Each sample had a considerable deposit of soot and dust on its surface.

A clean, wet cloth was rubbed twice over the surface of each sample. The first, a perfectly

smooth glass without patterned surface, was perfectly clean.

The second, hammered glass, was left with a small deposit of dirt in its depressions, though nearly as clean as the smooth glass.

The third sample used was a deeply scored prism glass. Its surface consists of a heavy V-shaped scoring that forms parallel ribs of distinctly prismatic form. After the test, this glass still had considerable dirt in the bottom of the V-shaped grooves.

The fourth sample, factory ribbed glass, has a surface similar to the deeply scored prism glass, except that its prisms are closer to each other and its grooves are not as deep. This type also had dirt in the bottoms of the scores.

The fifth type proved to be the most difficult to clean. This sample is scored both vertically and horizontally so that its surface resembles many small square pyramids with their points to the surface. This glass was almost as dirty after the test as it was before.

After cleaning each sample until all dirt was removed, the following report was made:

1. Smooth glass was easiest to clean.

2. Hammered glass was nearly as easy to clean as the smooth surface when a rotary motion was used.

3. Deeply scored prism glass, because of its smoothness, was cleaned easily when the cloth was rubbed in the same direction as the grooves.

4. Similarly, with the ribbed glass, it was necessary to exert considerable force to remove the dirt from the scores.

5. It was with great difficulty that dirt was removed from the surface of the double-scored glass.

Tinted glass is of particular value to manufacturers operating plants containing certain chemicals or chemical processes. One concern, operating a large plant in the South, is using amber-colored glass to good advantage in many of its plant units. Ordinary glass admits the sun's radiant heat and causes explosion of hydrogen gas that is present in large quantities. Amber glass, on the contrary, filters out the radiant heat rays and removes this hazard, but does not noticeably lessen the visibility within the building. Although the actual intensity of illumination is decreased by the colored glass, acuity of vision may even be increased. This is due to the fact that light admitted by the amber glass is more readily focused by the human eye because certain portions of the sun's rays are omitted.

Amber glass is used to a large extent in dirigible hangars in Germany. Here, too, absence of certain portions of the spectrum in the light within the buildings excludes the danger of explosion caused by expansion of the hydrogen gas with which most of these big ships are filled.

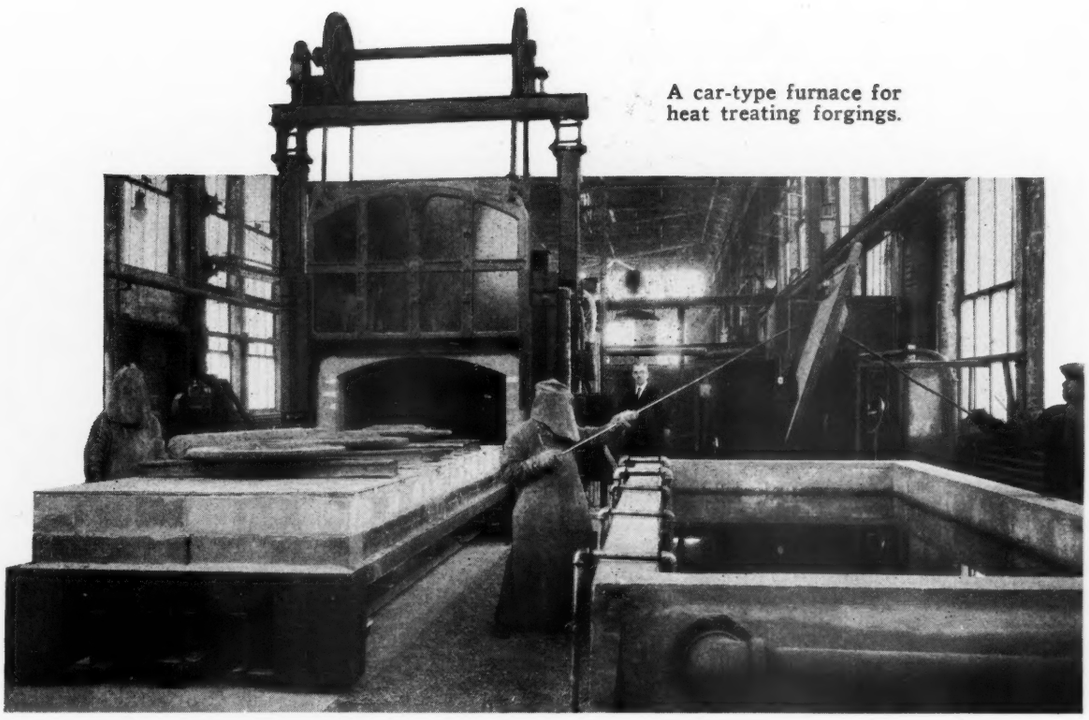
That the amber glass absorbs much of the heat in the sun's rays may be demonstrated by placing a piece of the glass in the sunlight next to a piece of ordinary glass. The colorless glass will remain cool while the amber becomes quite hot.

Condensation drip is a constant worry to manufacturers in some industries. This is particularly true in buildings where artificial humidity must be maintained. One drop of water in a batch of material may mean the loss of hundreds or even thousands of dollars. To prevent this constant hazard, many manufacturers resort to the use of double glazing.

Some manufacturers resort to the use of paint on the glass to lessen the glare. This method usually proves unsatisfactory, not only because it is unsightly, but also because the reduction of light is likely to prove serious on days when the sky is overcast.

All conditions, both inside and outside the buildings, that influence the establishment and maintenance of good illumination, must be considered by the engineer responsible for the design. The degree of precision required in manufacturing, exposure to dirt, cost of maintenance, human relations—all are essentials in the foundation which provides a basis for decision and selection.

This manufacturer believes in clear glass and uses it throughout his plant.



A car-type furnace for heat treating forgings.

ELECTRIC FURNACES

with controllable atmospheres

By C. L. HEISLER, JR.

Industrial Heating and Welding Engineering Department
General Electric Company
Schenectady, N. Y.

IN the design and operation of large furnaces certain precautions are observed owing to the inflammable nature of the gas. For example, hydrogen is explosive when mixed with air. The theoretical maximum pressures which can be obtained by exploding a mixture of hydrogen and air of 2.4 air-gas ratio, under an initial pressure equal to that of the atmosphere with varying conditions of ignition and time of firing, are given on page 48, bulletin No. 133, Engineering Experiment Station, University of Illinois. The curve shown in an accompanying illustration has been reproduced therefrom.

The air-gas ratio 2.4, a mixture containing one part hydrogen to 2.4 parts of air by volume, is the theoretical amount of oxygen necessary for complete combustion of the hydrogen. The maximum pressure given, 101 lb. gage, with initial pressure that of the atmosphere being a theoretical value, does not take into account the heat absorbed by the walls of the vessel during the explosion, which absorption, if present, tends to lower the maximum pressure. The bulletin gives the results of a comprehensive investigation of this subject.

This article deals with design and operation. The article in the March issue discussed control.

There is also reproduced herein an explosion curve for a hemispherical vessel showing the maximum pressures obtained experimentally by exploding various mixtures of air and hydrogen.

Danger of damage by explosion is practically non-existent with correctly designed and operated equipment. Years of operation have demonstrated the practicability of these furnaces, and that the explosion hazard, when operated by trained personnel, is very slight.

While the use of pure hydrogen will in general give the best results, producing bright work, clean and free from scale, satisfactory brazing can be secured with the atmosphere composed largely of nitrogen, with only a substantial proportion of hydrogen.

Also for certain operations, such

Complete equipment for annealing fine wire on spools.

as bright-annealing, when only a partially reducing atmosphere is required, it may be found advantageous to mix nitrogen or other gases with the hydrogen, which not only reduces the cost of the gas, but, when nitrogen is used, tends to reduce the possibility of explosion and to reduce the maximum explosive pressure which can be generated in accordance with known chemical laws.

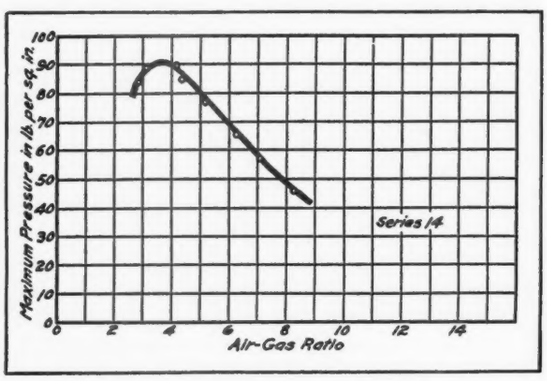
Annealing non-ferrous products—Brief reference has already been made to the water-sealed furnace for annealing copper wire. In some cases, and particularly for fine wire on spools, annealing in an atmosphere of artificial gas has been found desirable, as it eliminates the necessity of re-spooling the wire to wipe off the water held in by capillary attraction. The wire is likely to be stained or perhaps corroded if the water is not wiped off.

Also for bronze and other alloy wires, and for silver, nickel, etc., in sheet or fabricated form, atmospheres of artificial gas are well adapted. Although these applications are relatively new, a number of batch-type and continuous-type furnaces are now in successful operation.

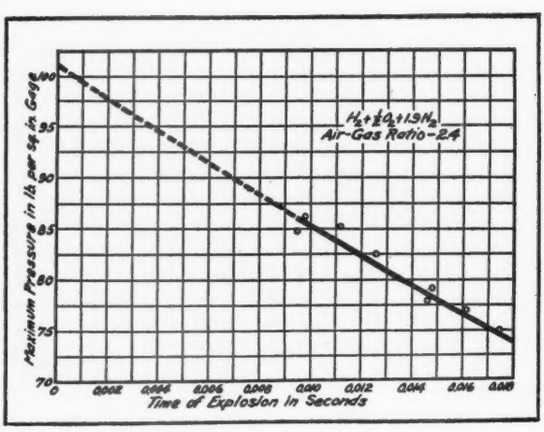
Complete equipment for annealing fine wire on spools is shown in another illustration. It consists of four stationary retorts with gas connections, and a portable heating chamber; one retort being heated while the others are cooling, or the loads being changed.

As the annealing temperature of these non-ferrous materials varies widely, the design of the furnace must be considered with regard to the particular material involved.

The characteristics of gases also vary with the temperature and pressure and other conditions of operation. For example, a gas under certain conditions of temperature might be neutral to the charge; that is, have little or no chemical effect upon it, but at higher or lower temperatures might be reducing or carburizing. Such a gas is methane, CH_4. The action of methane is reversible, thus—$CH_4 = 2H_2 + C$.



Explosion curve for hemispherical vessel with ignition at top and without turbulence.



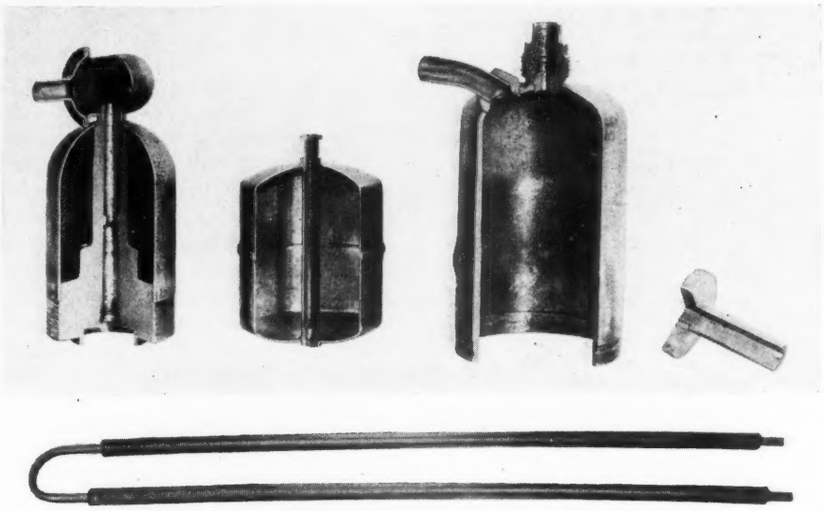
Maximum pressure-time curve for explosions of hydrogen and air.

If the action occurs more rapidly to the right than to the left, carbon will go into solution in the iron being heated (carburization), and if the action proceeds more rapidly to the left, carbon is removed, from the iron (de-carburization). However, if the two reactance velocities are equal, there will be no change in the carbon content of the iron. The atmosphere is neutral, or the reaction is in a condition of equilibrium.

The carbon content of the steel, the temperature, and pressure all affect the condition of equilibrium when methane is used as the gas, so that the balance in this case is delicate.

Nitrogen at low temperatures and low pressures for some purposes can

be considered as a neutral gas, but under high temperatures and high pressures, might have some chemical reaction with the material or other gases in the furnace. Nitrogen is inert and is made to combine with other gases or substances with difficulty, so that for commercial purposes, when used in furnaces operating at a pressure slightly above that of the atmosphere, nitrogen can be used and is used as a neutral gas.



Typical products assembled by copper brazing in furnaces with hydrogen atmosphere. Black lines indicate brazed joints. The steel fin is firmly brazed to the steel tube.

In general, where a neutral atmosphere is desired to prevent oxidation, it is found advantageous to have the atmosphere slightly reducing in action. Such an atmosphere is a mixture of nitrogen and hydrogen; the hydrogen content being of relatively small proportions, 5 to 20 per cent, depending on the conditions to be met.

For annealing copper in atmosphere containing hydrogen or other reducing gas, the temperatures should be kept below 400 deg. C. to avoid embrittlement of the copper. Commercial copper contains small amounts of oxygen as an impurity, which it is difficult to remove without special treatment. If heated to too high a temperature in an atmosphere containing hydrogen or other reducing agent, the hydrogen combines with the oxygen in the metal to form water vapor or steam, which, in effect, causes explosions between the crystals, resulting in embrittlement.

Slightly reducing atmospheres, as distinguished from neutral atmospheres, have the advantage that intrained air carried in by the charge is readily consumed, which may or may not be important depending on the temperature and other conditions of operation.

It is apparent from the foregoing that considerable study has been given to the subject of atmospheric control in furnaces, and considerable operating experience has been gained.

Study has also been given to means of supplying the gases at low cost, such as apparatus for dissociating ammonia into its constituent gases, nitrogen and hydrogen, and for dissociating illuminating gas, which also provides an atmosphere rich in hydrogen.

Electric furnaces with controllable atmospheres are destined to play an important part in industrial operations of the future, as automatic temperature control combined with atmospheric control provide, means to accomplish desired results, in many cases, in a better manner and at a lower over-all cost than usual methods now employed.

The World's Worst Belt

A FRIEND and I were exchanging power transmission experiences the other day when suddenly he asked, "What was the *worst* belt you ever saw?"

My reply appeared to be of much interest to him. These are the facts:

I was called to inspect a Diesel engine which the owner wished to dispose of because it "gave him too much belt trouble." The owner admitted that the engine itself was all right. He could find no fault with it as far as its running ability was considered but, he said, "It breaks the belt as fast as I can fix it. I spend most of my time fixing the belt."

I have seen many belts but never the equal of this one. I maintain that it was the "most patched belt in the world." And I also maintain that it was the "most poorly patched belt in the world." The word "repaired" can hardly be used because it is too dignified a word in this case, and, besides, the belt wasn't repaired. It was just simply "patched," and the patching was terrible. Originally, it was a double leather belt.

Every time the belt would break the owner would simply take a piece of belting of the same width, lay it over the break, drive some rivets through, clinch the rivets, and let it go at that. No attempt was made to produce a smooth-fitting joint. No tapering down to a feather edge. No gluing. No squaring up with a square. The patch was merely laid on top, and, you might say, "nailed on."

To be sure, the joint couldn't hold long. Another splice would then be riveted on top of the other, the owner doubtless thinking that two splices should be twice as strong as one. And when that, again, would break, the owner "simply couldn't understand it."

You see, the entire belt, all the way around, was made up of splices in this manner, overlapping and underlapping one another until the average thickness was about equal to that of three belts.

It has never before been brought to my attention so forcibly that whenever a belt needs repairing it pays to do the job right in the first place. In this instance, if the first repair job had been properly done it is quite possible that up to the present there would have been no need for a second repair job. The joint of a leather belt that is properly scarfed and cemented is just as strong as the solid leather belt itself. Leather laced joints are never as strong as the solid leather, but if the owner had even laced his belt instead of riveting in this unworkmanlike manner, he would have had much less trouble. Laced joints often have a joint efficiency of 85 to 90 per cent. A wire-laced joint could have been used as well as not and the writer believes it would have held.

Newark, N. J. W. F. SCHAPHORST.

Keeping Maintenance Abreast of Production

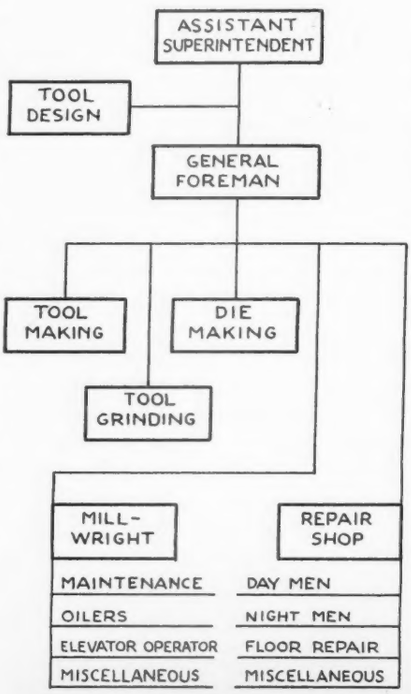
By H. R. WENTZELL

Assistant Superintendent Tools and Maintenance
Studebaker Corporation, South Bend, Ind.

WHERE production methods and equipment in an industry are in an almost constant stage of change, mechanical maintenance and repair activities become affected in direct proportion to the extent of the change. That, however, is not all for, with each succeeding change, records set up on past performance as a guide to follow and for future reference purposes, become obsolete. Orderly routine, once established for the continuity of operations, must be adjusted to meet the new conditions. Frequent changes are common to the plants of the automotive industry, and perhaps to many other plants whose product is also of a seasonal character. How the Studebaker Corporation, South Bend, Ind., has met the need for adjustment should be suggestive to others similarly situated.

Mechanical maintenance and repair activities are supervised by the Tool and Maintenance Division, which is set up according to the organization chart shown. By referring to the chart it is seen that there are three departments devoted to tools, and one to die making. Because this work bears no relation to the subject it will not be discussed. It is mentioned merely to acquaint the reader with the breadth of the work assigned to this division. Eliminating the foregoing activities, which are of a distinct character, there remains maintenance work of a purely mechanical character. All electrical work is handled by an electrical division, which is under other authority.

In the breakdown of this Maintenance Division there are two departments, namely Millwright, and Repair, consisting of 54 and 73 men respectively. Each department is supervised by a foreman, who reports to a general foreman, whose business it is to coordinate the activities of this division under the direction of the assistant superintendent.



For all plant changes involving the rearrangement of equipment and other machinery the division governs itself in accordance with the plans made up by the Layout Division where work of this nature originates. Here complete plans, which include layout, floor plans, assignment of machines, necessary ovens, conveyors, and so on to produce the new unit are made.

From this point the Tool and Maintenance Division begins its activity to bring the job to a successful conclusion. To do this it may be necessary to design tools to meet the new requirements, and after doing so it may be necessary to make them if it is impossible to have them made elsewhere. Afterward follow, in order, the installation and setting-up processes, and the maintenance and repair for which this division is wholly responsible.

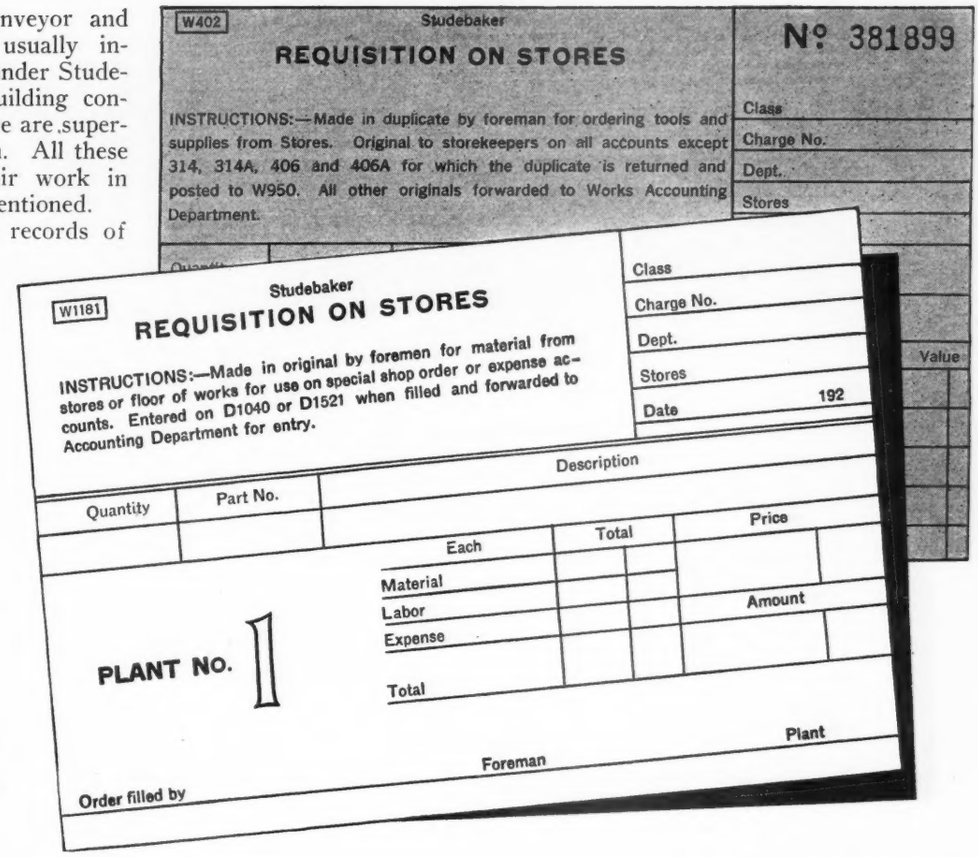
Other divisions provide the services not furnished by this division such as piping, which is taken care

A view of the mechanical repair shop there the principal mechanical services to production are performed.

of by pipe fitters. Conveyor and oven installations are usually installed by outside firms under Studebaker specifications. Building construction and maintenance are supervised by another division. All these divisions coordinate their work in cases of the character mentioned.

At one time accurate records of machine performance were carefully compiled, but it was found that the records had little real value because of the almost constant rearrangement of equipment. Only those records having real value were retained because new machinery was being added at a rate faster than old machinery was being

* * *



Two forms used in carrying on maintenance activities. Each form carries complete instructions for its use.

* * *

retired. The principal record at present is what is known as the Machinery Location Card, but listed as shown in the accompanying illustration as the "Equipment Transfer Order," which acquaints department heads with information concerning date of purchase, location, and what doing. Ordinarily a machine is not moved from one location to another except when the space occupied is required for other purposes. Considerably greater attention had to be paid to the maintenance of this equipment mechanically, consequently only such information as was required for inventory was considered of value. It was simply a case of adjusting the mechanical maintenance activities to the more important needs of the plant.

With the centralization of all manufacturing activities at one point these activities increased, as was expected, because of the great number of machine tools being added to those already installed. There are about 5,000 machine tools distributed among the body plant, chassis plant, press rooms, forge shop, machine shop, and foundry. Two departments, millwrighting and repair, were set up in the maintenance division as the most logical method of serving the plant's needs. A breakdown of these two departments as to personnel follows:

MILLWRIGHTING

Maintenance	23
Oilers	18
Elevator operators	10
Miscellaneous	3
Total	54

REPAIR

Repair shop (days)	34
Repair shop (nights)	6
Floor repair	30
Miscellaneous	3
Total	73

It will be noted that maintenance and repair are separate functions. Installing or changing machinery is the responsibility of a small group of millwrights. It includes the setting up of the tool and connecting it to the source of power, the drive medium being gears, chains or belts. From this point on the responsibility is divided between the machine operator and the floor repairman. It is a standing rule that the machine operator must oil his own equipment, but the floor repairman must keep it in first-class operating condition insofar as he is able with the means at his command.

When called upon by the machine operator having trouble, immediate adjustment or repair is made without any other authority. If a replaceable part is broken, a duplicate is obtained from stock providing the part broken cannot be repaired before production is affected. Sometimes it is necessary to have the entire machine forwarded to the repair shop.

These floor repairmen are distributed throughout the plant in strategic locations where they may be reached at a moment's notice by the members of the production crew whom they are serving. The necessary printed forms used by them for ordering material from stores, and for other purposes, are the same as those used in the repair shop, and which are shown in accompanying illustrations. They must first be approved by the particular foreman in charge, but where a machine is to be taken out of line to be rebuilt authority must be obtained higher up.

All other maintenance work done outside of the repair shop proper is accomplished by members of the Millwright Division. For instance, oilers are assigned to departments where they make two rounds daily lubricating all overhead and supplementary drives leading to the machines. In addition, 23 maintenance millwrights range all over the plant doing the miscellaneous jobs common to their line such as installing conveyor equipment, lineshafting,

W483 Studebaker

REPAIRS AND RENEWALS WORK ORDER

INSTRUCTIONS:—Made in quadruplicate by foreman for repair or renewal work as necessary. Original, duplicate and triplicate to division supt. for approval, quadruplicate retained. When approved, original to dept. which is to do work, duplicate to Works Accounting Dept., triplicate to general foreman of Tools and Dies Chassis Div.

Bldg. No. | Date

Floor | Charge Account No.

Dept. No.

Mr. Dept. No.

Please furnish this department

Signed

D1465 Studebaker ORIGINAL

EQUIPMENT TRANSFER ORDER

INSTRUCTIONS:—Made in quadruplicate by Layout Dept., original to foreman doing work, duplicate to Machinery Record Accounting Dept., triplicate to Division Superintendent and quadruplicate retained by Layout Dept. Machinery Record Dept. will use this form to follow up and see that records are kept up to date on machinery or equipment transferred from one plant or department to another.

No 14384

Transfer Equipment No. Serial No.

Description

From Department No. Bldg. No. Plant No.

To Department No. Bldg. No. Plant No.

Remarks

Signed

Date Charge Account No.

Facsimile of forms used when equipment is subject to transfer or repair.

and so on with their supplemental power transmission elements.

Lineshaft sections are driven by motors varying in capacities of from 10 to 50 hp., and loaded accordingly.

Single drives vary from 1 to 20 hp., and where large motors, 50 hp. and over, are used, they are usually overloaded from 5 to 10 per cent to assist the power plant in controlling plant power factor.

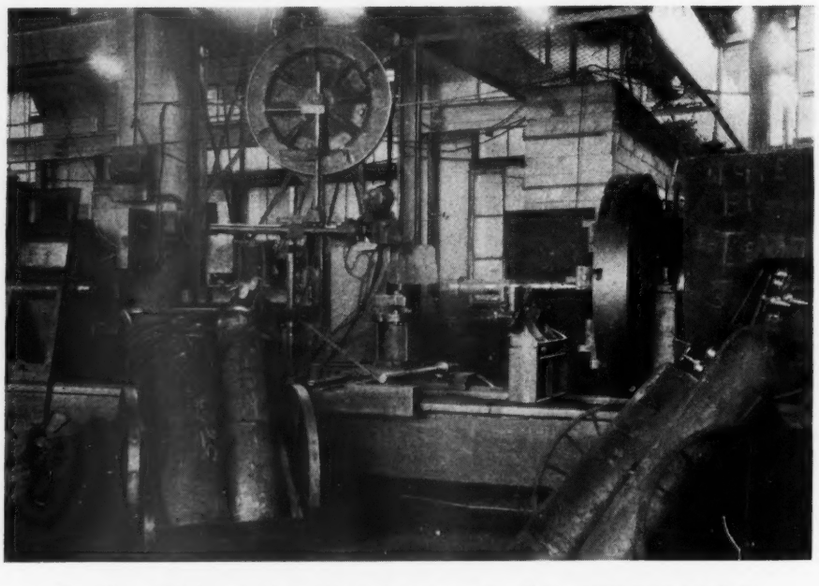
Adjusting the mechanical maintenance and repair activities to conform to production requirements is not the work of a moment, rather the effort of years, revising and reorganizing until the best method of attack is found for the present-day problems. For instance, there is the handling of belts and belting, also portable electric, and air-driven tools. These elements clear through the repair shop, although the responsibility for servicing them belongs to the millwright department. Two men are detailed to these services exclusively and, in addition, there is an oiler who goes throughout the plant oiling all air tools in service.

All unserviceable portable tools are sent to the repair shop where they are rebuilt or scrapped. New tools are tested there before being placed in service to determine if they function according to specifications.

From the various floor repairmen scattered throughout the plant there is a continuous flow of material to the repair shop, consisting of machine parts that are in need of repair in some form or other because of the lack of facilities for doing such work directly on the floor. When the material is received in the repair shop it is placed on a receiving platform until repair instructions are received.

In forwarding defective material to this point the floor repairman fills out a shipping tag with proper identification of the device and attaches it thereto. At the same time there is executed and sent to the repair shop foreman a shop order form detailing the necessary work to be done, and giving directions to dispose of the material when repaired. Samples of the Repairs and Renewals Work Order, and Requisitions on Stores Forms are shown in accompanying illustrations. These forms contain complete instructions for their distribution after approval for the work or material has been given so that the procedure in every circumstance is uniform.

Of the repair shop personnel six men are permanently assigned to night duty in the plant to do the necessary repair work that cannot be done conveniently during production time. Sometimes a machine part breaks in the course of the day's work and by rushing a portable welding unit to the place it may be possible to make temporary repairs which will keep the machine in service. If it so happens that welding is possible, or in fact, the only solution, these night men, one of whom usually is an expert welder, make permanent repairs so that the machine is returned to service in good condition.



Standby welding equipment kept in reserve for emergency repairs. The automatic arc-welding equipment is shown to the rear of the portable equipment.

PLANT · ENGINEERS' · FORUM

* * *

Here is the tenth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

* * *

How Big Is Maintenance?

With the evening meal over, or rather under, Frank Fulleger and George Shipman resumed their drive. It will be remembered that they are returning home after visiting a plant 100 miles or so distant from their own town. Before eating, they talked of what they had learned during the day concerning the operation of cranes, hoists, elevators, and trucks. Now we find them engaged with another topic.

* * *

"Good piece of steak, George; and those onions; and that pie—don't see how they can do it for eighty-five cents."

"Low overhead, quality buying, and judicious advertising, Frank. They feed three or four hundred people in there every night. Everybody knows the Green Shutter and how it maintains quality and service."

"Speaking of *maintaining,* George, reminds me of something Bill said this afternoon—that, while he is called plant engineer, and does the work of plant engineering, he's really a maintenance engineer."

Frank stopped talking, evidently wanting to allow time for the statement to sink in, or to get a reaction from Shipman. George didn't hurry his comment, and when he did give it, evidently said what Fulleger didn't expect: "Well, why not? After all everything depends upon the definition of maintenance. What is it? How big is it?"

"You sound like Bill, yourself," came back Frank. "Consider maintenance in its broadest sense," he said."

George broke in: "Then he went on, I suppose, to tell you that once upon a time maintenance was repair and nothing else—and deservedly so; but that as industry has grown and organized, repairing breakdowns has become passé; that the up-to-date maintenance engineer will foresee breakdowns and not let them happen; that he'll cast his vote for the selection of equipment that he knows by experience isn't likely to break down; that—"

"Wait a minute, George. Give me a chance—thought I was telling you what he said. If I hadn't stopped you, you'd probably have told me that he held forth on maintenance in its broad sense including installation and upkeep of all equipment, and the acquisition and handling of much of it."

"Yes, something like that; probably he said that the real maintenance engineer is the man who has the biggest, if not the last, word on all electrical equipment, mechanical power transmission apparatus, air conditioning, lighting, protection, signaling—"

"Are you sure you didn't write Bill's speech for him, George? You haven't enumerated quite all of the kinds of equipment he has to do with, and you've left out a few of his duties, but I suppose that's just due to lack of time."

"Maybe so, Frank—maybe so. At any rate, Bill and I are pretty well agreed as to the size of the maintenance job when properly handled. I may as well confess that I helped him form his conclusions some years ago. Helped him get the title 'plant engineer,' too, because 'maintenance engineer' wasn't so well understood then."

"How widely understood is this maintenance job as we've outlined it here, George?"

"Well, that's the question—"

* * *

And it IS the question. No other is needed in asking for discussion. You readers of INDUSTRIAL ENGINEERING *have your ideas. You've done things in certain ways in your plants. Some of the plants are big, others small. Join in on this discussion—let's see if we can clarify this situation for the Franks, Georges, and Bills who are going ahead along lines that they themselves worked out, but who would be heartened by a lively discussion with others. Let the editor have your discussion within the next three weeks on the subject:*

How Big Is Maintenance?

(Answers to previous questions start on the following page)

READERS' ANSWERS

to previous questions

Should Maintenance or Production Department Control Cranes, Elevators, and Trucks?

(Question Presented in the April Issue)

THE answer to this question cannot be settled by any set rule as each plant has its own style of operation and, obviously, what would suit one plant would be unsuited to another. In most cases I think that it would be better for cranes, trucks, etc., to be under the supervision of the maintenance department. Usually, where this type of equipment is used it serves more than one department and the problem naturally arises as to which department foreman should have charge of its operation.

Another reason why this equipment should be in charge of the maintenance department is that the production foreman usually has all he can do to keep his own department up to a certain standard of efficiency and has not time to see that equipment of this kind is properly operated and maintained. The average production department also lacks the knowledge and experience to select properly skilled and trained men for its operation.

I will explain why I advance these opinions on this question. I have had the following equipment under my supervision for a period of twenty years: ten 3-ton overhead electric traveling monorail hoists; six 5-ton crane transfer bridges, and a total of 17,000 ft. of 15-in. I-beam runway. For this period the electrical maintenance foreman has had full charge of this equipment, including the hiring of all operators and the training of new men. The plant in which this equipment is installed manufactures yellow pine and hardwood lumber of all kinds, and covers an area of one square mile.

The men are trained in the following manner: each hoist has a motorman and a hookman, who is trained to become a motorman. This training usually takes twelve months, at the end of which time he is given a regular hoist to operate. Part of this period he spends in the repair shop wiping and oiling hoists and familiarizing himself with all parts of the equipment.

Each hoist has a certain amount of work to be done, which is designated by the maintenance foreman. However, the hoists may be requisitioned for extra work at any time by any of the production foremen.

This system is used by nearly all of the lumber mills in the South and I have yet to hear of a case which failed to give good results.

H. BENNETT, *Chief Electrician*
Tremont Lumber Company
Rochelle, Louisiana

M. B. KRAMER
believes in giving the other fellow the benefit of his experience, and has done so many times, through the medium of this department.

How Develop Key Men for Maintenance Work?

(Question Presented in the March Issue)

AGAIN we have Frank Fulleger of the Old School, doubtful of the results to be gained by the use of new methods in his organization. He realizes that others are creating organizations around their key men and putting over big things, but he can't quite apply their ideas and methods to his organization, *which is different.* It is the same old alibi that has been used for ages and proved worthless, for along comes some young sprout who up and does the impossible. Is Frank to blame? Yes, for he has personally supervised the work, instead of delegating it to others, for so long that he thinks others not capable of doing their own thinking.

Through constant trial and error, men will in time gain experience, so as to build up their knowledge, and in self-defense will start to think for themselves. Why permit this costly method to take its course? Pick out the key man who is the best in his class of work, place him in charge of a group of understudies, and let him train them through practical applications of the key man's trials and errors, plus practical application in the correct way. They, in turn, will begin to think along the right lines and develop other and quicker methods of applications of old ideas.

These key men, in turn, can be potential foremen—foremen who will themselves delegate their detail jobs to key men under them, giving themselvs more time to go into the major supervisory work, free from the worries of petty details.

The man who tries to carry his job totally upon his own shoulders is passé and should realize that he is not making his job more secure by so doing; in fact, he is holding himself back from possible promotion because he knows his job so well and has guarded it

so closely that the company can't afford to move him ahead, for there are no capable understudies to take his place.

Train your men in the specialty class; get rid of minor details through trained key men; hold them responsible for results; turn them loose to develop in their field, then back them up when they come across with new ideas; spend more time on the major problems and personal development; and then lead your organization instead of guide or drive it. There will result a coordinated group of organized workers that will have the backbone and stamina to carry on through most any obstacle that may arise, plus the added security of a potential group of understudies that can step up and replace those above them when that time comes.

MERLYN F. STEPHENS, *Industrial Engineer*
Precision Castings Company, Inc.
Fayetteville, N. Y.

WHERE size of plant is considerable and where nature and amount of equipment, machines and auxiliaries permit proper grouping, the development of key men is the logical order. The procedure also has been found practical in many small concerns where special tasks require only a fraction of the time of such men.

The development of key men proves very effective where a maintenance organization is large enough to permit a segregation of the work into several departments under a general foreman or with each department directly responsible to a foreman or assistant foreman reporting to the head of the maintenance department. Such a split-up may consist of (1) Electrical, (2) Pipe and steam fitting, (3) Steam plant, (4) Machine shop, (5) Structural, fabricating, heat treating, etc., (6) Millwright and field repair work, (7) Carpenter and rough cabinet work, (8) Lubricating, (9) Elevators and plant transportation, (10) Sanitary, etc.

In an organization where the amount of work does not warrant such numerous divisions or where one or more of these departments dovetails into another it may be advisable to combine such sections; while under other conditions it may be desirable to make still further sub-divisions.

Whether the activities of all these departments are to be conducted by a plant engineer or several assistants is again one of industrial treatment, depending upon size and variations in production department maintenance requirements.

In every industry the details to be entrusted to key men will vary. In an electrical department, for instance, the following responsibilities have been allotted to such individuals with highly satisfactory results: Motors, phones and cable work, transformer and control equipment, batteries. Work of the pipe and steam fitting crew is of a more general nature, but here, too, the care of traps and heating system in a fair-sized plant is best handled in such manner.

Care of special equipment entrusted to the machine shop also is done advantageously through key men; this may involve various inspections, care of instruments, gages, meter records, scales, etc. Even such routine jobs as floor repairs, repairs to freight elevators and plant transportation equipment, machinery guards, window glazing, special transmission equipment, and a hundred other items of routine nature will respond

CHAS. A. PETERSON

has been a contributor to *Industrial Engineering* for some time. His views on many of the Forum's problems should interest all maintenance men.

with lower costs where men have become especially skilled in the classified requirements.

Inspection and minor adjustments is an item of no small importance which, for best results, should be detailed to the various key men, under the supervision of a department engineer or maintenance head. Thus the responsibility for condition of equipment is definitely fixed and controlled.

The following, in brief, are the results where the development of key men is found practical and is closely adhered to:

1. Timely inspection, with minor adjustments where necessary, thus eliminating more costly repairs and unnecessary shut-downs.
2. A minimum of outside service charges and consequent overhead.
3. An invaluable aid in getting accurate data on trials, records and segregated costs.
4. A nucleus of skilled men in dull times.
5. Definite responsibility.
6. A minimum of follow-up required.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company
Niagara Falls, N. Y.

How Shall Equipment Be Purchased?

(Question Presented in the February Issue)

THERE cannot be established any arbitrary standard or rule as to whether equipment shall be purchased as a unit or in parts. Three factors govern the placement of orders:

1. Is the type of equipment to be purchased only once?
2. Is it to be a new standard unit?
3. Must it be procured in a hurry—rush order?

The average large factory, for instance a glass factory, is not a machine factory. Even if the plant does boast of a very well equipped machine and maintenance shop, most new articles or machines, such as a conveying system, blower, cleaner, or whatever may be needed, must be purchased outside. It would be foolish to have the machine itself and the driving power bought from different firms. In most cases such

G. A. HOLMES
master mechanic, is an active contributor, and is in a position to see many of the problems discussed in this department worked out "in the flesh."

units can be bought standard or assembled with the motor. Even though there should be a slight difference in price, the assembly of those parts would eat away the profit, to say nothing of the overhead and the details of requisitioning and purchasing.

When a machine of new design and larger dimensions is needed, some parts thereof could be considered as one unit. Let us consider a roller system of 15 rollers with gear boxes as a drive-in-line and the rollers with ball bearings and casings. In purchasing, it would be better to secure the fifteen rollers, bearings, and casings as one unit, even if the bearings were purchased at a higher price. The gear boxes assembled could be purchased in a different place. In my opinion, it would be foolish to purchase each item separately and then have the maintenance crew assemble the job.

When ordering parts to fractional dimensions there is a limit of plus or minus 0.005 in., sometimes even more, and if more exact dimensions are not specified on the blue print the parts will show a slight difference.

Consider a shaft and bronze bearing order. On a bearing one can specify fractional dimensions and call for a reamed job. However, if the shaft is made in another place, it often happens that the ream is off 0.001 in. or more and the shaft and bearing will not fit. For such a job, it would be wiser to have both parts made by the same company and call for a slip fit.

When an order must be placed in a hurry, of course there is no question as to whether or not to get the entire unit from one manufacturer. It is evident that one hour's loss of time, or a short delay in production, will more than offset any saving the purchasing department might make by shopping around. Even though the purchasing department of a large company can show an immense actual saving by its careful handling of jobs for lowest prices, when such procedure results in delays in installation of equipment and poor assembly of the parts, the savings probably will be wiped out.

Sometimes there is needed a unit not on the market in the dimensions desired. The question of a new design comes up. In such a case it may be advisable to buy a similar unit and have it fitted to the special need. If the maker cannot handle the change then the maintenance crew or machine shop must do so.

There should be an understanding between the maintenance and the purchasing departments and the two working together can save the company a great deal of money in the purchase of equipment.

C. SCHAFER, *Research Department*
Libbey Owens Glass Company
Toledo, Ohio

Who Shall Do the Salvaging?

(Question Presented in the December Issue)

THE salvaging of equipment is probably one means of paying dividends that is to a too great extent overlooked. It is not always an easy matter to decide whether the most profitable method of disposition is by salvaging or by junking. It is a well known fact that junk is worth so much a pound, but it is not always apparent whether a piece of salvaged equipment is junk plus the charges for salvaging.

As to who shall have the final decision regarding salvage, it hardly appears logical to invest this authority with any one in particular, not even the plant manager or plant superintendent. While the plant manager may have the authority, the master mechanic or electrical superintendent may have much more knowledge regarding the piece of equipment that has apparently reached the bone-yard stage, and have better ideas of what use can be made of it.

Every industrial plant should have a junk yard as well as a storage shed for equipment that, while still useful, is not required for the present. Not every plant can afford a salvage crew; in fact there are very few plants that maintain what is known as a strictly salvage crew.

In the ordinary plant, however, the salvaging is and can be done quite easily by the regular maintenance crew with the probable assistance of some of the production crew in the event of a bad breakdown. Suppose a heavy gear breaks; the master mechanic and the millwrights will know immediately whether it can be welded and put back into service or should be scrapped.

If a spare is available and it is possible to repair the broken unit, it is much better to have the millwrights remove it than to have the work done by a sledge hammer crew. It can then be properly repaired and made ready for future use.

Valves and pipe fittings taken out by the pipe crew will give greater salvage return because they can be examined at once, and if worth salvaging can be taken to the machine shop for repairs and replacements. The same reasoning applies to shaft hangers, belts, broken parts of machinery, etc. Belts that are split often can be cut for some other application by an experienced mechanic. Scrap copper from motor and control repairs has nothing but a scrap value and should therefore go to the junk yard.

All parts that have been salvaged and repaired, such as valves, pipe fittings, castings, pump runners and casings, etc., should go into the stock room in preference to a separate storage, since when placed in stock there is every reason to believe they will be used at the first opportunity, while if they are placed in a separate storage, they are more often forgotten and soon become junk.

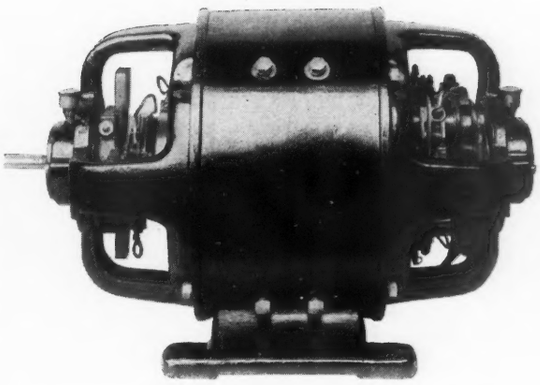
To sum up, the disposal and salvaging of equipment should rest entirely with those directly responsible for maintaining the equipment; records should be kept, by means of tags, of the cost of repairs on every piece.

Cases are not unknown where a large percentage of the maintenance costs have been redeemed by careful salvage methods.

H. E. STAFFORD, *Electrical Engineer*
Port Arthur, Ont.

Mechanical Causes of Slip-Ring Troubles—

and Their Remedies



A rotary converter showing the proper setting of brushes; 180 electrical degrees apart.

By S. S. WOLFF

Chief Engineer
American Electric Motor Company
Cedarburg, Wis.

THE PROBLEM of obtaining satisfactory commutation and brush operation on direct-current machines involves a careful study of commutator construction, operating conditions, selection of the proper brushes and the efficient maintenance of the machine. The difficulties encountered are usually as much of an electrical nature as they are mechanical and the two are very closely related. In fact, when commutating troubles occur in many instances, the correction of mechanical defects often eliminates what supposedly were electrical defects.

Too much stress cannot be placed upon the importance of eliminating the minor causes of improper commutation before attempting to diagnose the trouble. For example, the incorrect bedding of brushes may often be the cause of serious commutator troubles. It must be remembered that commutation difficulties never iron themselves out, but on the contrary, cause increased aggravation the longer they are permitted to exist.

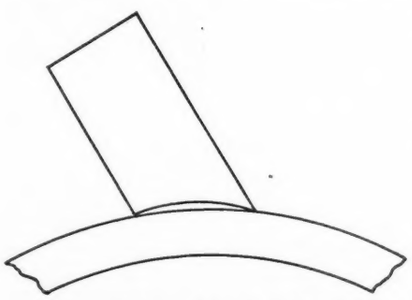


Fig. 1—When using a fixture to sand in the brushes, its radius should be slightly less than that of the brushes.

It must be understood that the question of slip-ring operation is somewhat different from that encountered with direct-current commutators. The problem here is almost entirely one of a mechanical nature.

The important thing is to create and maintain perfect contact between the brush and the slip ring.

Two main factors to be considered in selecting the proper grade of brush for slip rings are the current density in the brush under operation, and the radiating surface of the rings. In the older types of machines, where low densities were employed and where the rings had large radiating surfaces, graphite brushes were used with very satisfactory results. These brushes ran very cool and afforded considerable lubrication. They wore slowly and produced very little dust.

However, in the present day machines, where it is desired to keep the efficiency as high as possible, a brush having a low contact drop is used. In addition, the radiating surface of the present slip ring has been considerably reduced. The limits thus imposed by recent practice have made it necessary for machine designers to employ brushes of a metal graphite type. The required copper contact of these brushes will vary from 50 to 90 per cent, depending upon the current density present in the brush.

As a rule the types of brush holders which give the best results on slip rings are no different than those used on direct-current machines. The number of brush holders to be used is governed by several factors, all of which must be taken into consideration. The use of large brushes and very few holders means a simpler construction. However, large brushes are more sluggish than medium-sized brushes and will not ride on the ring as well. Increasing the number of brushes per ring means better contact between the brush and ring because of the fact that each brush can be bedded individually. The number of brushes to be used is also influenced by the electrolytic action which takes place between the ring and brush.

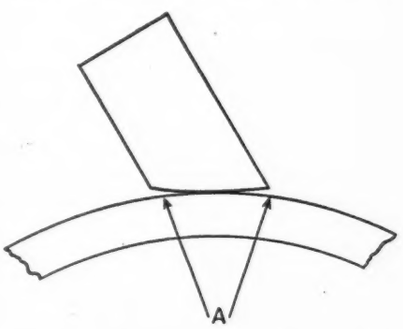


Fig. 2—When too large a radius is used, wedge-like spaces exist between the brush ends and the ring. In the illustration this point has been exaggerated for the sake of emphasis.

The operation of bedding brushes is a very important one, and the one which oftentimes is performed very

inefficiently. In selecting the proper grade of brush, the designing engineer has based his current density calculations upon 100 per cent contact between rings and brushes. If this condition does not exist, it often means that the brush is operating under an excessive density. The ill effects of this condition cannot be eliminated by allowing the machine to operate until the brushes are worn in. The brushes must be bedded properly before the machine is fully loaded. The task of bedding metal graphite brushes, especially the ones having a high metal content, is not a pleasant one. A large brush is particularly difficult to bed. A great deal of time is necessary and the operator must be very patient. The use of a large number of small brushes makes it a somewhat easier task because a small surface can be bedded rather quickly.

Many of the manufacturers today purchase their brushes already ground to the correct curvature of the ring upon which they are to be used. When various sizes of rings are employed, this is not possible. However, when this is the case, the brushes are ground to a fairly large radius and much time in bedding is thus saved. The proper method of bedding brushes is to place the brushes in the holders applying considerable tension on the springs and then draw a piece of carborundum cloth forwards and backwards until the brush assumes the proper curvature. This process should then be repeated with fine sandpaper. In the case where reaction-type brush holders are used, the sandpaper should be drawn against the direction of rotation. When this has been completed the holders and brushes should be carefully cleaned and care should be taken to see that no sand is embedded in the face of the brush.

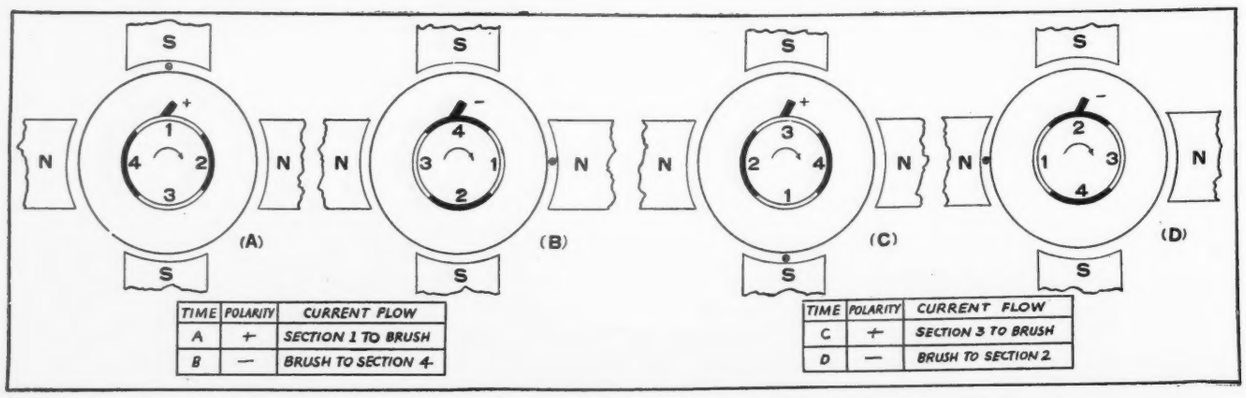
Grooves cut in the slip ring are oftentimes caused by abrasive material which is left embedded in the face of the brush.

In some cases it is not convenient, or almost impossible to bed the brushes on the contact surface upon which the brushes are to operate. When this condition obtains, it is best to sand the brushes on a fixture to a curvature whose radius is slightly less than that of the slip ring as is shown in Fig. 1.

When too large a radius is used, as shown in Fig. 2, wedge-like spaces exist between the ring and the brush at the edges marked A into which dust is drawn by the revolving ring. This has a tendency to lift the brush away from the ring. When placing a set of new brushes into service, the machine should be operated at no load for a while and as the brushes wear in, a load may be applied to the machine and increased gradually as the contact surfaces of the brushes increase. When this procedure is followed, the brushes will not overheat, nor will any burning action take place on the rings owing to poor contact.

In this case, we have assumed that there is only one brush per ring. In position A, the brush has a positive polarity and the current flow is from the ring to the brush. During this interval, metal will flow from the ring to the brush. The same is true during the time that the conductor is in position C except that the flow of metal takes place on the opposite side of the ring. When the conductor passes through the positions B and D, the brush has a negative polarity and the current flow is from the brush to the ring. During these two intervals, there is no flow of ring metal. These results are tabulated in connection with Fig. 3. This electrolytic action will cause the sections 1 and 3 of the slip ring to wear while the sections 2 and 4 will not be affected. The result is that two long flat surfaces will appear on the ring. The same condition will also hold true in regards to the other rings on the machine.

Now let us assume that two brushes are required to carry the output of this machine instead of only one brush. If the brushes are mounted diagonally opposite, we would have the same condition as shown in Fig. 4. During the interval E, the flow of metal is from sections 1 and 3 to the brushes. In the second period F, no flow takes place and in positions G and H, these results are duplicated.



TIME	POLARITY	CURRENT FLOW
A	+	SECTION 1 TO BRUSH
B	—	BRUSH TO SECTION 4

TIME	POLARITY	CURRENT FLOW
C	+	SECTION 3 TO BRUSH
D	—	BRUSH TO SECTION 2

Fig. 3—Diagram showing one brush per ring and the four positions which are assumed by a conductor on the armature of an alternator when it makes one complete revolution.

As mentioned before, an electrolytic action takes place when current flows between the rings and brushes which results in passage of metal from the ring to the brush and causes the ring to wear. This flow of metal is in the direction of the flow of current. The spacing of the brushes on the ring must be taken into consideration and the brushes so arranged as to prevent the uneven wear of the ring caused by this electrolytic action.

Referring to Fig. 3, we have the four positions which are assumed by a conductor on the armature of an alternator when the armature makes one revolution. The corresponding polarity of the slip ring is also shown.

Assume also that the brushes are now respaced so that they are 90 deg. apart as shown in Fig. 5. During the period J, the metal flow is from ring sections 1 and 2 to the brushes. In the period shown by K, the current flow is from the brushes to the sections 4 and 1. In L, the metal flow is from sections 3 and 4, to the brushes while in M, the current flow is from the brushes to sections 2 and 1.

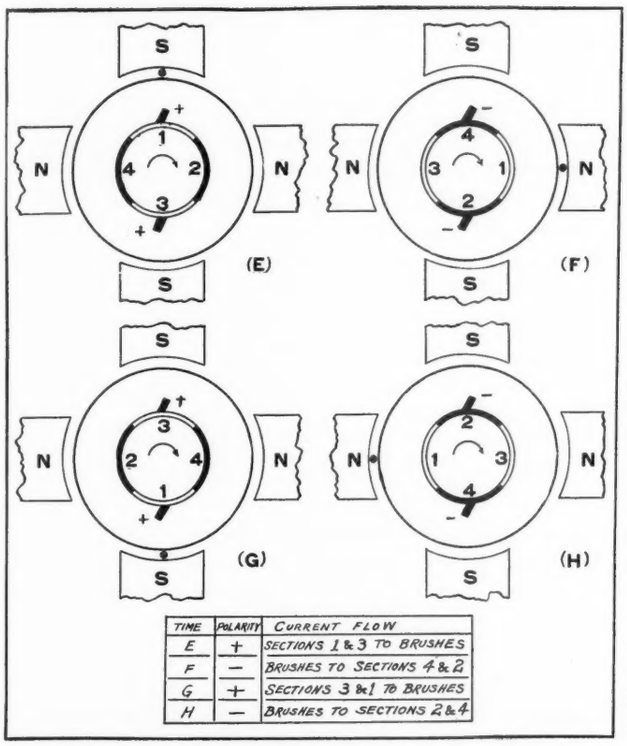

S
N
(E)
(F)
(G)
(H)
TIME | POLARITY | CURRENT FLOW
E | + | SECTIONS 1 & 3 TO BRUSHES
F | − | BRUSHES TO SECTIONS 4 & 2
G | + | SECTIONS 3 & 1 TO BRUSHES
H | − | BRUSHES TO SECTIONS 2 & 4

Fig. 4—This diagram illustrates the same principle as in Fig. 3, except two brushes are required to carry the output of this machine.

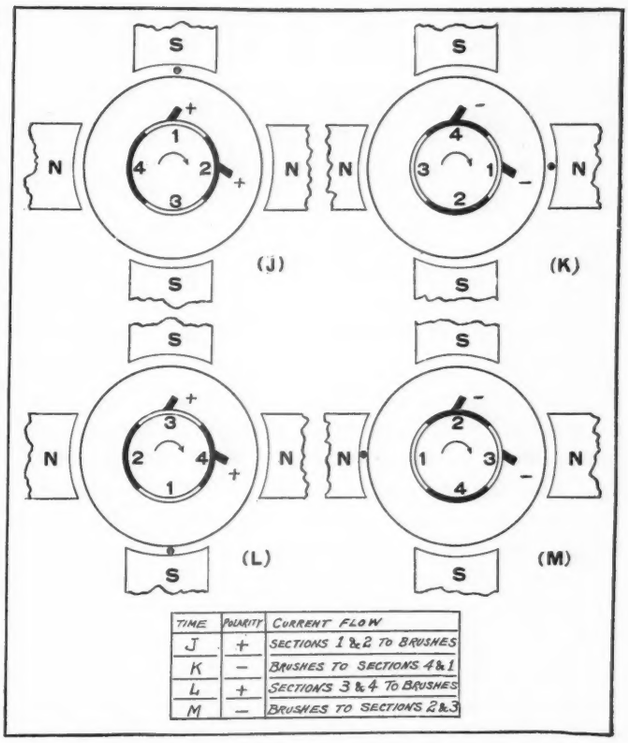

S
N
(J)
(K)
(L)
(M)
TIME | POLARITY | CURRENT FLOW
J | + | SECTIONS 1 & 2 TO BRUSHES
K | − | BRUSHES TO SECTIONS 4 & 1
L | + | SECTIONS 3 & 4 TO BRUSHES
M | − | BRUSHES TO SECTIONS 2 & 3

Fig. 5—The brushes here are spaced 90 deg. apart. Each section of the ring is acted upon equally thereby preventing flat spots.

In this diagram we see that each section of the ring is acted upon equally by the flow of current and hence no flat spots are formed. A four-pole machine was used here for simplicity, but it will be found that in the case of any multi-pole machine, the most perfect condition is to have the brushes mounted in pairs and spaced 180 electrical degrees apart.

This electrolytic effect on the rings will not cause an appreciable movement of the brushes in their holders and hence cannot be detected very easily. However, these flat spots become larger in time and cause poor contact between the brushes and rings. On some special types, steel rings are frequently used. These rings tarnish when the machines are left standing idle for any length of time. This tarnish is usually not distributed around the ring and, as a result, flat spots develop. A remedy for this condition is to wipe the rings off with a rag moistened with oil just before shutting down.

Stroboglow Makes Moving Objects Appear Motionless

OBJECTS in motion are now made to appear motionless when viewed with the aid of the Stroboglow, a device which employs lights that are regulated to flash at intervals corresponding to the speed of the moving object. With it, it has been possible to read markings on an airplane propeller revolving faster than 1,000 r.p.m. At the same time propeller quiver and cracks, and engine valve action became visible.

This portable and compact device is the product of Westinghouse research laboratories. Other uses for it include the visual determination of belt slip; vibration of meshed gears; movement of valves in gasoline engines; the difference in speed between motors, turbines, disks, etc.

Sufficient darkness to render the lights visible on the moving object is the only requirement for its operation.

Stroboglow and revolving airplane propeller that was made to appear motionless. By means of this instrument revolutions per minute are accurately determined.

INDUSTRIAL ENGINEERING

L. C. MORROW, *Editor*

Vol. 88 MAY, 1930 No. 5

Springtime Calls for Housecleaning

GOOD work *can* be done in poor shops. Everyone knows of good cobbling that comes from dingy shops, of high-grade printing done in uninviting quarters, of first-class machine and tool work from shops that have a forbidding appearance.

However, aren't places of that kind one-man shops, or at any rate so nearly one-man shops that the owner can put a part of his own personality into each article that goes out? The owner has vision, or is an artist, or is working for the day when he can have a decent place. He can inspire a few employees with the same spirit.

In large plants, where almost everything is impersonal, appearance counts. The ambition of the worker leans more toward accomplishing his own welfare than the welfare of the plant. His pride and sense of well-being make him want to work in a good-looking, sanitary, well-lighted, painted plant. He likes a place that is dressed up outside as well as inside. Lawns, shrubbery, and trees; well-kept walks; plumb fences—all are important.

All of which means that good housekeeping is an asset. In the springtime, Nature makes easy our job of brightening up outside the plant. Let's meet her at least half-way there, but not forget to do the whole inside job ourselves.

Maintenance on Premium?

INCENTIVE payment for maintenance work is a subject of rapidly increasing interest. Maintenance is on a premium basis in some plants. A few engineering departments know how to set standards and determine time allowances. A few industrial or management engineers have made successful installations.

By and large, however, we don't know much about the job. On first consideration, the task of setting standards appears too big. "Who can tell what is going to happen?" we say. Or, "Where will the next breakdown occur? If we knew that, we'd prevent the breakdown and there would be no necessity for incentive."

Perhaps that's the wrong way to begin to look at the job. In the first place, maintenance isn't confined to repairing breakdowns; that definition is out of date, obsolete. Repairing breakdowns is only the necessary evil of maintenance.

Modern maintenance prevents breakdowns. It provides regular and systematic inspection that detects the conditions which will cause breakdowns if not corrected. Then it corrects those conditions.

Modern maintenance provides, prior to such inspection, modern installation; before that, selection based on engineering knowledge.

All of which involves the keeping of plant history, which consists of performance and repair records.

Maintenance inspection provides one opportunity for incentive payment; either the basis of time consumed in the operation, or time of operation without failure may be used. The right kinds of records will give a basis for setting times on actual repair jobs. Then there is routine work: painting, cleaning, rebuilding, all of which may be paid for on the unit-of-area basis.

Once launched, incentive payment for maintenance will uncover its own possibilities. Doesn't seem like such a terribly difficult task. Probably what's needed more than anything else right now is for a few maintenance engineers to work up the courage to come out and tell how they have done the job in their plants. Yes, *Industrial Engineering* is willing to be the clearing house for your experience stories.

Put Signs to Work in the Plant

SIGNS in the plant are time-savers; sometimes they are safety devices. To wit:

There is great advantage in framed and mounted signs indicating the location of valves, alarm boxes, fuse panels, switches, telephones.

There is no excuse for pulling on the wrong hoist rope when the handle of that rope is an arrow pointing in the direction of travel.

Certain corners in the plant provide dangerous turns for trucks. Some doorways are so located that they offer hazards in the transportation of material. In such cases, simple instructions to truck operators, prominently displayed, prevent accidents.

Operations or processes involving explosive or highly flammable materials make essential the absence of anything that might cause combustion. Again signs are of value.

The instances cited are only a few. Any plant can find many opportunities to use signs to advantage. If the subjects are judiciously selected, the wording properly arranged, and the locations for mounting well chosen, each plant can have a permanent directory always available to prevent accident and to direct action in case of emergency.

The Middle-West Acquires a Lighting Institute

ANOTHER lighting institute has been established—this one in Chicago. Manufacturers and distributors of lighting equipment and electric utility companies are operating it co-operatively. The industrial room, a major part of the institute, is of two-story height and is a work-shop wherein the actual work can be tried out under a variety of lighting units located to suit the job.

Industrial plants are taking their own sweet time in adopting scientifically planned artificial lighting. Probably they would be advancing more rapidly if there were more permanent installations where they could see what proper illumination is. It's one thing to visit a plant having a set plan and specific equipment, but quite another to go where flexibility of arrangement and multiplicity of equipment enable comparison to be made.

Because it is centrally located, and because of the spread of interests operating it, the Chicago Lighting Institute will hasten the day of universal good lighting in the Middle-West.

High Price—Low Price?

BUYING on price alone is not good policy. Price is an influence, an important one, may be the controlling one. When objects are identical, the one with the lowest price should be bought; that's good business.

The rub comes in finding identical products. Workmanship differs, materials differ, designs differ. It is upon such differences as well as upon price that the competition of today is based.

What to do? Buy upon analysis, or upon your own specifications, or upon the manufacturer's statement of specifications. Buy for what the equipment will do for you. Don't condemn a product just because the price is high; find out why. It may turn out to be a low price when the work it does is taken into account.

Saving Pennies on Lighting and Losing Dollars in Production

"LIGHT costs money; so let's use smaller lamps, or reduce the number in use, and thus save money." Some such reasoning seems to be behind the misguided efforts that are frequently made to cut down expenses in times of stress, or during the economy waves that periodically strike every establishment.

That this viewpoint is ridiculous almost to the point of absurdity hardly needs to be demonstrated. Nevertheless, concrete examples of it are not difficult to find. In a good many instances, an up-to-date lighting system that would give reasonably adequate illumination has been installed at considerable expense in industrial plants. Then it has been realized that the lighting bill has been, or would be, increased, and an order has gone forth to cut down the number or size of the lamps. The results are almost invariably unfortunate.

In the first place, the workers are denied the advantages of good illumination; consequently, their output usually suffers in both quality and quantity. Accidents and mishaps go up, and morale goes down. Again, failure to take full advantage of the service that the new lighting system could give means that much of the money invested in it has been wasted.

Unfortunately, too, there is a tendency to blame the illuminating engineer for laying out what may later be regarded as an unsatisfactory system, whereas the real trouble lies in failure to carry out his recommendations.

Cutting out waste of light by the use of automatic light-control units, or by exercising closer supervision and making sure that lights are turned off when not needed, is highly to be commended. When properly done, it will often result in worth-while savings. However, reducing the amount of light needed for production is simply to limit the workers' supply of an absolute necessity, and leads to losses in other directions.

Good Housekeeping—An Investment

AN engineer who has bought some hundreds of thousands of dollars' worth of equipment during the past few years took occasion to say some things about his buying habits.

One thing he said was that if he is comparing two machines, and one appears to be about as good as the other, he makes a point of seeing the two plants where the machines are made. He then selects the machine made in the plant that is using the more modern equipment.

It's only a step from influence by equipment to influence by the other features of the plant—housekeeping, maintenance, lighting, condition of buildings, yards, and grounds. These features go hand in hand with modern equipment. Like modern equipment they inspire the personnel with pride in product and workmanship, with loyalty because the place in which they work is attractive.

All of which means that money spent for shrubbery, flowers, lawns, paint, lighting equipment, cleaning equipment, and everything else that goes into good plant housekeeping is for investment, not for waste, not even for speculation.

This Month's Cover

ON the front cover of this issue is shown Kodak Park, Rochester, New York, the largest plant of the Eastman Kodak Company, makers of photographic film (including x-ray film and motion picture film), photographic materials and accessories; Kodaloid, a transparent nitrocellulose sheeting, and basic nitrocellulose; film solutions for the manufacture of artificial leather, lacquers, etc.; and related products.

This plant covers 400 acres and contains 120 odd buildings with a floor space of over 4,600,000 sq. ft. Most of the machines in the plant are driven by individual motors of which there are about 4,200. There is a total of approximately 6,000 motors within the plant, of approximately 35,000 connected horsepower. The total capacity of the power plant supplying current to these motors, and to approximately 42,000 lights, exceeds 17,000 kw. Steam is supplied by two boiler plants capable of developing a total of 26,000 hp., which furnishes steam for heating and process work through the by-product generation of power and refrigeration. During 1929, 35,900,000 kw.-hr. were generated and 19,000,000-kw.-hr. were purchased from the local power company. The coal consumption reaches a maximum of over 700 tons per day during the winter.

Filtered water is supplied from Lake Ontario, five miles away, by means of a company-owned pumping station capable of furnishing 16,000,000 gal. of water per 24 hr. to a 5,000,000-gal. reservoir located under one of the buildings at Kodak Park. A pressure of 100 lb. is maintained in the several miles of mains and at 115 fire hydrants throughout the plant by means of a section station having a pumping capacity of 25,000,000 gal. per 24 hours.

Buildings subject to fire risk are protected by automatic sprinklers and the plant has a fire department of 150 men. Four overhead steel tanks, with a total storage capacity of 230,000 gal., maintain constant pressure on the fire mains to which are also connected two auxiliary fire pumps, each with a capacity of 1,000 gal. per min. Conditioned air and refrigeration for manufacturing processes are supplied by two refrigeration plants of 9,000 tons capacity per 24 hours.

Plant Engineering at Kodak Park is in the hands of the Engineering and Maintenance Department. The head of this department is the Assistant Works Manager, and reporting to him is the Superintendent of Engineering and Maintenance, who has jurisdiction over four assistant superintendents. One of these four assistants is in general charge of the execution of all construction and maintenance work, and reporting to him is a master mechanic. The foremen of each shop report to the master mechanic, and a general foreman in charge of field maintenance also reports directly to him. The plant is divided into zones, each of which has its own maintenance gang with a field foreman reporting to the general foreman.

Employees at Kodak Park number about 8,000, of whom about 800 are employed on maintenance, alterations, and replacements.

Another Use for Standard Pipe Fittings

WHEN fittings for pipe structure were originally designed, their application to switchboard structures was the only object.

It was not long before other useful applications were made, owing to their adaptability and simplicity of installation.

At the present time, this list has now increased to include not only switchboard frames, but outdoor substations, racks, railings, pipe line supports, cable supports, and sign structures, however, the most recent use is for stock bins and shelving, such as shown in the illustration.

The particular problem involved was the economical storage of the various sizes of boxes and packages which, in the vocabulary of the storage warehouse, would come between the bin stocks and the floor stocks. Standard steel shelving units, of course, provide for the smaller bin stocks. The larger lots of uniform size boxes are no problem at all in floor stocking, but the smaller lots of the intermediate size packages waste considerable space either stacked on the floor or piled on to steel shelving.

The accompanying illustration shows very clearly the space-saving features of the new shelving, as the maximum height of storage, before the construction of the new shelving was underneath the first shelf.

Pipe fixtures used as frame structure for shelving in a Chicago warehouse.

Structural pipe fittings 1¼ in. in size were used together with extra strength pipe of the same size. The structure is anchored by the use of 1¼ in. to 1 in. reducers and 5-in. nipples at the top of each upright, the nipples being backed out of the reducers against the ceiling. The shelf construction is of ordinary pine boards cleated together about 3 in. apart. These cracks or openings between the boards are left to provide for the easy flow of water from the sprinkler system in case of fire.

This construction provides for a much greater variety of applications than the standard steel shelving. The shelves can be set at any height from 3 in. above the floor and up. The uprights are clamped to the long pipes in order to increase or decrease the openings between the uprights at will. If storage is required for heavy material necessitating greater strength, uprights can be moved closer together or additional ones very easily added. If a very light stock, such as lamps or glassware, is to be stored, a still greater distance apart for these uprights would be permissible and very easy of accomplishment.

This shelving could be made entirely fireproof by replacing the wood cross members with steel.

· QUESTIONS ·

Asked and Answered by READERS

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Vacuum Tube Control of Power Circuits

I understand that a few installations have been made that employ vacuum tubes in connection with other equipment for controlling considerable amounts of power. Can anyone tell me what kind of equipment is used for such purposes and what the principle of operation is? Also, for what applications in general is this method of control best adapted? G. M. C.
Chicago, Ill.

What Materials for Elevator Brake Linings?

A question has come up regarding the best materials for lining the brakes of passenger and freight elevators. I wish that readers would tell me what material or materials are most widely used for this purpose, with the advantages and disadvantages of each. C. H.
San Diego, Calif.

Reinforcing Structural Members

When installing conveyors and other equipment, it is sometimes necessary to cut away portions of channels and I-beams in order to provide sufficient clearance. For example, we recently had to cut two 4-ft. x 4-in. sections from the bottom of a 15-in. channel, 16 ft. long and supported only at the ends. Of course, the channel was considerably weakened and the problem of reinforcing it was an important one, as the channel was presumably carrying its full load. I shall appreciate it if readers will tell me how to determine the kind and amount of material needed for reinforcing structural members from which portions have been cut out, size and spacing of rivets, and so on.
Mt. Carmel, Pa. W. J.

Repulsion-Induction Motor Exceeds Rated Speed

If anyone can help me with the following problem I shall be grateful. We have a G.E., Type SCR, ¾-hp., 1,750-r.p.m. repulsion induction motor that developed worn bearings. New bearings were installed, the commutator resoldered and turned, and the rotor and stator were tested for shorts and grounds. When the motor was assembled and tested without load the speed kept increasing until it reached 2,700 r.p.m., when the switch was pulled to prevent damage. The brush yoke has not been moved, and the two brushes were sanded to a good fit.

The motor behaves very erratically. Sometimes it will start properly and run at about 1,800 r.p.m., but an ammeter in the circuit will swing about 60 strokes a minute, and vary about 25 per cent. At the next trial, the motor may speed up until we have to pull the switch. Where should I look for the trouble? F. W. E.
Denver, Colo.

READERS who are interested in this department are invited to submit questions for discussion, as well as their solution of the problems presented by others. Questions need not necessarily deal with problems that you have not solved: even though you have found an answer to a puzzling situation, discussion may bring out different, and perhaps better, ways of handling it, and will be helpful to other readers who may be facing the same problem.

What Pipe Size and Discharge Pressure?

Operations within our plant are somewhat dependent upon an adequate supply of water. In the dry season the plant is seriously handicapped because the stream supplying excess water dries up. There is an abandoned quarry 1,053 ft. distant, from which we can draw on in case of emergency for all the water that is needed.

We can either pump to our reservoir or direct to the point of application. The latter is preferred as it offers protection in case of fire. For this work we have a 300-g.p.m., 1,140-r.p.m., 150-ft. head centrifugal pump. The difference in elevation plus 20 ft. suction head is 83 ft. There will be three 90-deg. bends in the line. What is the most economical size of pipe needed? We have enough 3-in. pipe to build the line and almost enough 4-in. pipe. What maximum pressure can we obtain on the discharge end of the line? Would throttling the discharge end of the line for maximum pressure overload the motor specified for the pump?
Dunmore, Pa. P. B.

Connecting Armature of Repulsion Motor

I wish some reader would tell me how a straight repulsion motor armature is connected. This armature has 24 slots in the core and 48 bars in the commutator. There are three wires on each bar. Also, I should like to know how the armature and stator of a repulsion motor can be tested for grounds, and short and open circuits. I have not been able to obtain satisfactory results with a growler, as it always indicates a short circuit. H. O.
Buffalo, N. Y.

Use of Ampere-Hour Meter on Storage Battery Trucks

In our plant we are using a number of battery-operated trucks and tractors. As these are employed in widely-separated sections of the plant, it has necessitated the use of three charging sets, and the daily charging of the batteries has been left to the discretion of the operators, with rather poor results.

I wish some of our readers would advise us on the practicability of installing ampere-hour meters with full-battery trip breaker on our trucks, to control the charging. Your help will be appreciated. C. E. S.
Sanford, Me.

ANSWERS *to* QUESTIONS

Paint and Putty for Damp Location

In the department where we shrink shirt material, an excessive amount of moisture is present in the air, and causes the walls and windows to drip water. This condition, in turn, softens the putty and causes it to crumble and fall off the steel window frames. I should like to know whether there is any special kind of putty that would give better service, or something that could be mixed with the putty we are now using to make it more resistant. I should also like to know what is the best kind of white paint to use on the steel girders in the same department. The paint we now use does not last more than three or four months, and then the ironwork starts to rust again. Is there any treatment we can give the ironwork before repainting, that will help us to obtain better results?
Hazelton, Pa. E. B. W.

REFERRING to E. B. W.'s inquiry, we have a similar problem in our beater and machine rooms; although we have not completely solved the problem, we have made considerable improvement in the service obtained between paintings.

I consider that the best method of attacking the problem is to eliminate the drip, which can be done by maintaining a layer of warm air under the ceiling and down in front of the windows from ducts supplied with outside air heated by fan coils. Naturally, this involves considerable expense for heating. Also, there are times when the heating system does not function properly, and drip is present, so that adequate protection of the ironwork is necessary.

To provide this, E. B. W. should scrape all ironwork thoroughly and paint it with two good coats of a high-grade blue lead paint, which will stick to the iron in spite of moisture, if applied when dry and allowed to dry properly. Then he can use the present white paint on the girders and elsewhere.

In place of putty in the window sash use one of the calking compounds, which are similar to roofing cement. This material seems to adhere better than putty, and is easy to remove when the glass breaks. H. D. FISHER.
Plant Engineer,
New Haven Pulp & Board Company,
New Haven, Conn.

WITH reference to the question by E. B. W., I would suggest that he try a putty which we have adopted exclusively in our plant. It is known as Sterelastic, and is made by The Arco Company, Cleveland, Ohio. This putty is elastic, as the name implies, and is easily removed when glass replacement is necessary. It does not "creep" away from glass, as ordinary putty will do, permitting rain and moisture to work through. We use a slate or grey color.

If glass is mounted in transoms, which are likely to be inverted, the glass should be held in the frame with the wire loops usually provided for this purpose on steel sash. I mention this for the reason that the compound referred to above does not harden as ordinary putty will. Although it seals better than putty, it will not sustain the weight of the glass if the transom is inverted and the weight carried on the puttied side instead of on the sash frame.

For ironwork exposed to the weather, we have used a paint marketed by the Inertol Company, New York City. This material is available in two colors: black, which is better for the under coat, and reddish-brown, which may be used if the black color is objectionable. We have not tried to use white paint over this material, but I can see no objection to doing so. However, I would suggest that the advice of the manufacturer be sought on this point. J. W. CURRAN.
Maintenance Engineer,
Boston Gear Works, Inc.,
Norfolk Downs, Mass.

MY opinion is that if E. B. W. will clean the steel sash thoroughly with a wire brush, removing all rust and paint, and then give it two coats of Triple A solution, manufactured by the Quigley Furnace Specialties Company, Inc., New York, N. Y., he will have no trouble in making the putty hold. I should, however, use a plastic glazing compound instead of putty. This material gives better results, never becomes brittle, and can be obtained in several colors.

For the girders and other ironwork, use the same protective medium, but be sure that there is no loose paint or rust on it, or the coating will not adhere.

I have used these solutions for more than two years, with great success, in a tannery where the conditions are death to paint. CLARENCE A. GIBBS.
Herkimer, N. Y.

FIGHTING corrosion and the other troubles mentioned by E. B. W. can best be done by giving the girders and steel window casings a coat of some good inhibitive paint before applying the finish coat. The latter should be a lead-linseed oil paint of good quality. Before applying the inhibitor, clean off all scale and rust with a wire brush. The surfaces to be painted must be clean and dry if good results are to be obtained. The presence of moisture in the air is injurious even when the paint is drying. A good inhibitive paint is usually slow drying, requiring between 48 and 72 hours.

For the windows, paint the sashes and lights (where the putty should hold) with the inhibitor. Then use the best grade of putty and when it has set give it a coat of the inhibitor.

If I were E. B. W., I would go a step farther and attempt to control the moisture in the air by installing suction fans over the tubs or vats and carrying off the vapor-laden air. The resultant improvement in working conditions might well lead to increased production by raising the morale of the workers. CARL A. WAGNER.
Denver, Colo.

Voltage Will Not Build Upon Generator

A puzzling case of trouble has developed on a 35-kw., 115-volt, compound-wound, d.c. generator. The commutator bars became loose and the armature was sent out for repairs, although the generator ran satisfactorily except for considerable sparking during heavy loads, and rapid wear of the brushes.

When the generator was reassembled after repairs had been made, we checked all connections, but the voltage failed to build up. On the possibility that the fields had lost their magnetism, we charged them with a 6-volt battery, without result. By exciting from an outside source, we are able to light only two 60-watt lamps. Will someone kindly tell me the probable cause of our trouble and how to locate it?
Huron, S. D. B. H.

IN many cases such as B. H. reports, I have found that the repair shop did not properly check the armature connections, and when reconnecting the leads made the lead throw one bar more or one bar less than it was originally. When this happens the generator will not pick up, if run in its original direction of rotation. The remedy is to change the commutator connections, or what is much more easily done, reverse the field connections.

It is possible also that the field coils are bucking each other, which will prevent the machine from building up. Again, sufficient turns in part of the field coils may be shorted out through moisture or otherwise to prevent building up. MARTIN T. LANE.
Service Foreman,
Southern Nebraska Power Company,
Superior, Neb.

ANSWERING B. H.'s question, if the armature leads had to be disconnected from the commutator, it would be advisable for him to check the connections carefully.

When connecting the leads to the commutator, care must be taken not to change from a progressive to a retrogressive connection, or vice versa.

If this change is made, a generator will not build up with the original external connections.

I would advise B. H., first, to try to remagnetize the fields, using 115 volts. This can be done by lifting the brushes and placing paper between them and the commutator. Then fasten the negative wire from another generator to the negative line of the generator to be remagnetized and tap the positive wires together lightly two or three times.

If no 115-volt direct current is available, he might try shorting the leads of his generator with small fuse wires. Be careful not to cause a flashover between the leads.

Should this procedure fail to bring the voltage up, the armature connections to the commutator must have been reversed. In that case, B. H. will have to reverse the field connections or the armature connections. Inasmuch as it is easier to reverse the field connections, I would advise him to do so, and believe he will find that his generator will then function normally.

N. H. MAILHOS.
Electrician,
Southern Advance Bag and Paper Company,
Hodge, La.

Is Back-Torque Operation of Slipring Hoist Motor Harmful?

We are having trouble with the brake of a 75-hp. slipring induction motor that operates a hoist. In order to save the brake, the hoist operator was instructed to lower the skip by applying current in the hoisting position. The question has come up as to whether the motor may be injured or partially burned out.

After the hoist had been operated in this way for some time I felt the motor and found the temperature was about normal, but the resistance grids were very hot. I should like to know whether there is any danger of injuring the motor by operating it in this way, and whether it can be considered good practice.

Flin Flon, Man., Canada. A. P.

REFERRING to A. P.'s question, with the friction brake out of commission the present way of operating is probably the best. With the hoist at the top level, the controller can be turned in the hoisting direction until the hoist starts to rise; then the dogs can be released and the controller turned back a notch toward the "off" position. With the motor exerting a little less positive torque, the weight of the empty skip overcomes the hoisting effort of the motor, and the skip will lower by what is commonly known as motor "back torque."

The motor is taking energy from the supply lines, which is used in holding back the descending skip. As the motor nears the stopping place, the controller is advanced a few notches toward the full "on" position, cutting out resistance in the motor secondary and causing the motor to exert more hoisting torque. This brings the skip to rest; then the controller handle should be quickly brought to the "off" position; otherwise the skip will start to rise.

The main disadvantage of this method of operating, and the reason it is not in general use, is the unstable speed condition. That is, for comparatively small changes in the weight of the descending skip, there will be large changes in speed. If the overhauling load is 50 per cent of full load, it will be possible to lower at 50 per cent of the hoisting speed, assuming that the correct amount of resistance is cut into the motor secondary. An increase in the skip load from 50 per cent to 65 per cent will double the speed of the descending skip. A corresponding decrease in load will be enough to stop the skip altogether, and if the decrease were a little more than this, it would start to rise instead of lowering.

If the weight of the lowered skip is always the same, the resistance can be adjusted to get practically the same speed every time a trip is made, but if either a little more or a little less weight is added on an occasional trip the operator should be ready to cut a little resistance in or out of the secondary circuit of the motor. The current taken from the supply lines by the motor will be only about 50 per cent of full-load current for 50 per cent overhauling load. If the overhauling load is 100 per cent of the motor capacity (which is very unlikely), the motor will be drawing about 100 per cent current from the line.

In lowering any kind of a load, the friction in the hoist itself, caused by the cable running over sheaves, losses in the gears, windage, etc., are all helping to hold the load back and consequently are assisting the motor and reducing the amount of current drawn from the line. Also, as the skip is probably being lowered empty, the load on the motor will always be considerably less than full-load motor rating, and the current will be less than full-load current. For this reason, there is small chance of the motor overheating, but, due to the fact that a portion of the secondary resistance is always in circuit during the lowering period, it should be watched for any possible overheating. If the resistor is designed for starting duty only, it is being subjected to more severe service than it was designed for.

Previous to having brake trouble, the lowering was probably done by throwing the controller handle quickly to the lowering position and lowering the skip by regenerative braking; that is, the motor pumps current back into the line. This differs from lowering by "back torque" wherein current is taken from the supply lines. Lowering by regenerative braking also has the advantage of stable speed characteristics. When the motor reaches the stopping place, the friction brake can be gradually applied, and at the same time the controller handle brought to the "off" position, opening the line circuit.

Without the use of the brake, it is possible to stop the motor by "plugging" it to rest; that is, as the motor approaches the stopping position, the controller is reversed from full "on" lowering position to the first point (second or third points, if necessary) in the reverse direction. This method, however, takes a large power peak from the line and the sudden inrush of current might cause the windings to be distorted, unless the motor has been especially constructed to withstand the strain.

R. F. EMERSON.
Industrial Engineering Department,
General Electric Company,
Schenectady, N. Y.

ANSWERING A. P.'s question, we have been operating a 75-hp., three-phase, 550-volt hoist motor in the following manner for the past five months with no harmful results:

Our motor operates a two-drum hoist which may be used in counterbalance when required. In hoisting singly, after starting in the usual manner, the skip is brought up the shaft with the controller wide open. It is then emptied at the dumping station and as soon as the skip starts to descend the controller is reversed, taking care to start in the same manner as in hoisting, only more quickly accelerating until the controller is again wide open.

In this position, the resistance grids are out of circuit which makes it impossible for them to heat while the motor is operating under these conditions. As the skip nears the proper level, the controller is quickly brought to the "off" position and the brake applied to bring it to a standstill. With this method of operation, the brake is used only for a few seconds each trip, which greatly lengthens its life. When lowering men, it is advisable not to use this method because should an obstruction de-rail the skip the operator would have no warning as to what happened.

The speed at which the skip descends is practically the same as when it is hoisted, because the motor in both instances keeps in step with the frequency of the power supply, which makes it difficult for the motor to run away so long as it is in circuit. When using the motor to brake the load in descending, the first notch from the "off" position of the controller would allow the motor practically to run away, but as the controller is opened up the motor speed is retarded and brought into step with the frequency.

JAMES G. CRAFT.
Electrician,
Coast Copper Company,
Vancouver Island, B. C., Canada.

What It Costs to Have a Clean Factory

By H. C. CHARLES

CLEANLINESS in the manufacturing plant, or in other words good housekeeping, is a problem that has come up for a good deal of consideration. It is generally conceded by every good manager that his building must be kept clean if he is to obtain and retain the highest type of employees. The average factory executive has also come to the full realization that he cannot offset cleanliness in the plant with higher wages.

Realizing that the factory must meet certain demands with regard to sanitation, cleanliness, and healthful working conditions, the manager is vitally interested in the degree of cleanliness he must maintain and the cost of such maintenance. Obviously, the cost of cleanliness increases rapidly after a certain point has been reached.

In a general way, janitor work in the plant can be divided into the following phases:

1. Office janitor work. In many plants, we find the janitor work progressing throughout the day with a clean sweep scheduled during the night. Obviously, sweeping of floors cannot progress during the working hours. Therefore, the janitors must have some other duties during such periods. Under this heading may be placed the cleaning of windows, pictures, lamp shades, polishing of brass, and other minor duties. Generally, sweeping of the office may be placed on the same schedule as household sweeping, that is, about once every 24 hours. In a large, well-kept manufacturing plant, the cost of office janitor work equaled 0.2 per cent of the total payroll. For every hundred office employees two janitors were required. These janitors took care of the sweeping of floors, dusting of desks and tables, scrubbing twice weekly, washing of windows, and polishing of brass. In this plant modern equipment was in use, such as vacuum cleaners, efficient polishing equipment, and scrubbing machines.

2. Washrooms, locker rooms, and toilets. This phase of janitor work can be carried on during the day throughout the factory and after work hours in the offices. In the modern plant, lavatories are of high quality similar to those used in the average home and therefore should receive equivalent care and attention. The proper quality of cleaning powder must be at hand and special brushes should be available. With the proper kind of equipment and efficient labor, this work should not exceed 0.4 per cent of the total payroll or approximately four janitors for each hundred workmen. In a large plant where the wash rooms were of modern design and where each employee was provided with an individual locker, three such janitors were employed for each hundred employees.

JANITORS REQUIRED FOR 100 EMPLOYEES

Duties	
Office cleaning	2
Washrooms, lockers, etc.	4
Factory sweeping	6
Refuse handlers	5
Machine cleaning	3
Yards and streets	3

These are average figures and vary with the type of industry.

3. Factory sweepers. The factory must be swept daily from one end to the other. The amount of dirt accumulated on the floor varies with the type of industry. However, in a large automotive plant numerous time studies showed that the average sweeper can take care of approximately 18,000 square feet of floor space in nine hours. In this particular plant the sweepers were given an extra hour in which to make a final clean-up at the end of the work day so that no oily waste, rags, or other combustible material was left laying around on the floor or in corners. For the entire plant, including machine shops, assembly shops, shipping rooms, storage warehouses, and other portions of such plants, six sweepers were employed for each hundred men.

4. Refuse handlers. Under this heading in a metal working plant would come such employees as steel-turnings handlers, chip handlers, and workers of similar nature. For example, in the receiving department there accumulates a large amount of packing boxes and scrap which must be removed. In the paint department considerable paint clings to the spray booths, the floor, and other places which also must be removed. All of this refuse must be taken from the plant and burned either under boilers or in refuse burners suitably located. In the metal-working plant mentioned, the cleaning group consists of five men for each hundred workmen. However, this can be reduced to three men for each hundred employees as proved by comparison with other plants of this nature where more efficient means for the removal of refuse are in use. For example, paint spray booths may be covered internally with grease and ordinary building, or wrapping paper. When the paper becomes paint laden it is merely pulled off the walls and burned and new paper used with grease as the gluing medium. Well-designed steel containers are positioned along the machine lines and throughout other departments into which the janitors deposit all refuse to be carted away later by means of hand trucks or tractors.

5. Machine cleaning. The up-to-the-minute manager has learned that machinery lasts longer when properly and systematically cleaned. Therefore, machine janitors are necessary in the average manufacturing plant. The number of such men necessarily depends upon the type of machines in use. In the above-mentioned plant this number is about three men for each hundred employees. It requires as high as two hours properly to clean some machines; however, it is only rarely necessary to clean a machine oftener than once every 48 hours.

6. Yard and street janitors. Obviously, yards and streets must be kept clean. However, street sweepers of modern design make this a comparatively simple matter. In general, three men per hundred employees will cover the work in this class.

Power Drive Analysis

Conditions Unfavorable

By WILLIAM STANIAR

Mechanical Power Engineer
E. I. du Pont de Nemours & Company, Wilmington, Del.

IN a new plant, the existence of inefficient mechanical transmission installations proves conclusively that either little thought has been given the subject, or there has been a lack of knowledge on the part of the man responsible. In an old plant where modernizing has been attempted, inefficient transmission is frequently unavoidable regardless of consideration or knowledge.

Modernization of an old industrial plant presents power problems that are frequently difficult to solve because of the introduction of modern equipment, existing obstacles owing to the type of building construction, and the rearrangement of old machinery. Modern apparatus receives, and has its power controlled differently than apparatus of the past; therefore, to adapt modern drives to old mechanisms, particularly where they are arranged in conjunction with modern designs, it is often necessary to employ methods of driving that are not practical.

In addition, the modernizing of equipment and not the building causes structural hindrances to economical power transmission in the form of unalterable columns, cross girders, walls, piping, operating platforms, etc., all of which must be taken into consideration when attempting to drive what might be termed a mixture of old and new machinery.

Unfavorable conditions, both atmospheric and mechanical, are generally presented in the revamping of an old plant for the efficient transmittal of power because of new processes and the periodical installment of new apparatus. There is no flow sheet or routing diagram; therefore, the problems must be solved as they arise by careful thought and by means of a selection of the most suitable equipment. Transmission problems of this character cannot all be solved by the use of any one method, a fact that should be realized when the attempt is made, if continuous trouble and expense are to be avoided. It is because of the great variety of equipment and methods available, and the possibility of combining the two, that an attempt can be made to transmit power economically and efficiently under favorable conditions.

An old plant being remodeled or enlarged requires more direct thought as to power transmission and distribution than a new one, chiefly because of limited space and varying speeds of operation. Practically no two plants or conditions are alike; therefore, it is impossible to generalize on the subject, in view of which an endeavor will be made to assist the plant engineer by discussing a

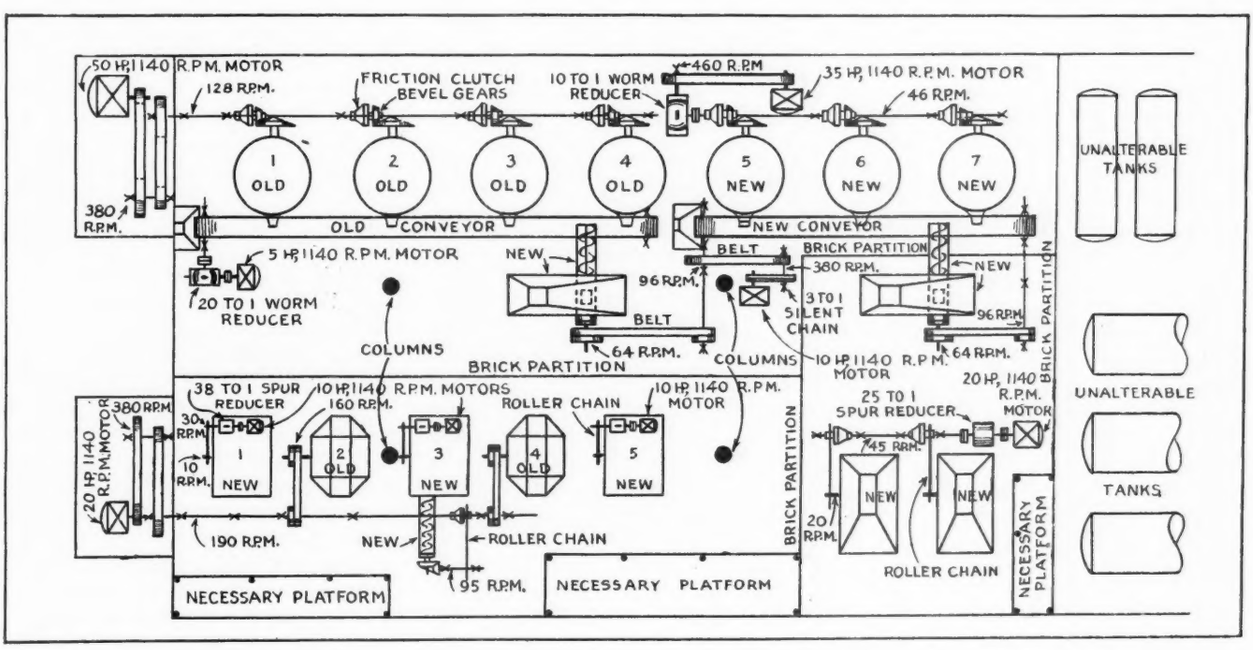


Fig. 1—Plan showing the effect on power transmission by the modernizing of equipment and not the building.

typical example of machinery addition and rearrangement embodying a variety of transmission problems in an unalterable building.

A plan layout of a remodeled chemical manufacturing plant is shown in Fig. 1, in which it has been necessary to arrange the mechanical power distribution to suit unalterable building conditions. Before remodeling, the equipment consisted of four mixers, indicated as Nos. 1, 2, 3, and 4, group driven and clutch controlled from a 50-hp. motor located in a motor house. The material from the mixers was delivered to a belt conveyor which was driven by a 5-hp. motor through a 20 to 1 ratio worm reduction gear. On the opposite side of the building were located 5 mills, similar to Nos. 2 and 4, group driven through tight and loose pulleys by a 50-hp. motor which was also located in a motor house. In the end of the building opposite to the mill installation was a general mixture of machinery no longer necessary. Owing to increased demands on the plant which necessitated a different type of apparatus, almost a complete rearrangement was required. Immediately adjacent to the building in which the rearrangement was to take place was a system of tanks that could not be changed, and, owing to the fire hazard of manufacture, the brick partitions in the building in question could not be removed. Therefore, it was necessary to adapt the power transmission systems to the space available.

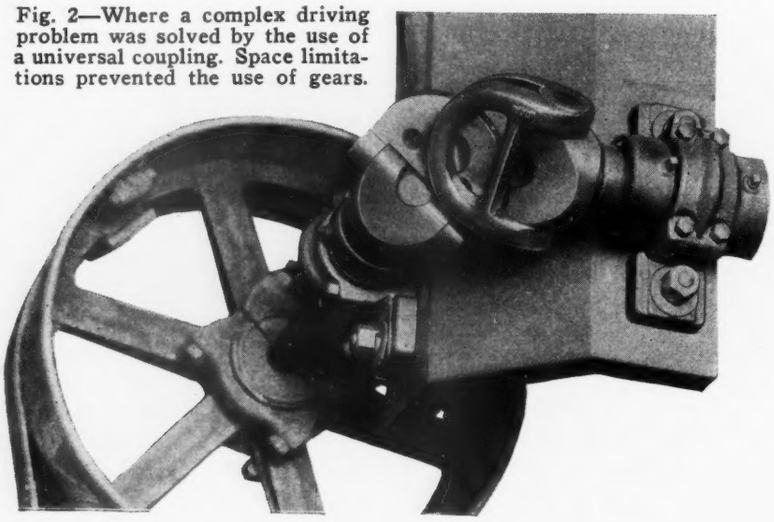
Increased production necessitated three new mixers, indicated as Nos. 5, 6, and 7, arranged in line with the four old ones. Inasmuch as they were to operate at much slower speeds, it was evident, immediately, that they could not be connected to the present group system of the old mixers, nor could they be driven by a similar group system because of the presence of the tanks in the adjacent building. To drive them individually would have been poor economy, so the group system was resorted to with power applied in a different manner.

Based on the lower speed of the mixers, it was possible to run the group line shaft at 46 r.p.m. which made feasible the introduction of a 10 to 1 ratio worm-gear reduction unit coupled direct to one end of this line. The reducer was driven by a 35-hp. motor, belt connected, with a ratio of 2½ to 1, resulting in a worm speed of 460 r.p.m. It was necessary to provide a new conveyor for the additional mixers, but it was impossible to drive it in a manner similar to that of the former installation because of the presence of an immovable building column at the point of drive. In view of this, it was necessary to resort to a chain and belt system from a 10- instead of a 5-hp. motor based on almost double the speed of the conveyor. The chain connection between motor and head shaft was used because the location of the column and the brick partition did not allow sufficient belt-center distance. The motor was suspended from the ceiling and silent-chain connected with a 3 to 1 ratio to a head shaft which was then belt connected for a 4 to 1 ratio to the head pulley shaft of the conveyor.

In this plant the change in process required material fed to the belt conveyors by screw conveyors from ovens located as shown. Fortunately, the driving of these screw conveyors was not difficult because of the possibility of belting the one feeding the old conveyor from the head pulley shaft of the new conveyor, and the one feeding the new conveyor from the tail pulley shaft of the new conveyor. The required speed of the screw conveyors was 64 r.p.m., and based on the fact that both head and tail shafts of the new conveyor operated at 96 r.p.m., it was an easy matter to obtain the required 64 r.p.m. by the installation of shifting belts on approximately a 45-deg. angle.

In regard to the 5 mills operating on the opposite side of the building, the change of process required that three of the five should be replaced by apparatus of an entirely different design and operating at 10 instead of 160 r.p.m. Two of the five mills, indicated as Nos. 2 and 4, were to remain in operation at the same speed. This condition presented a difficult problem of power transmission because the new 10-r.p.m. machines could not be driven from the old group line operating at 190 r.p.m., since the group line had to remain to drive the old mills, its driving motor could be reduced in size from 50 to 20 horsepower.

Fig. 2—Where a complex driving problem was solved by the use of a universal coupling. Space limitations prevented the use of gears.



From a viewpoint of initial costs, it would have been preferable to drive the new mills, Nos. 1, 3, and 5, as a group, but it would have required the installation of a heavy, slow-speed line shaft driven by a 30-hp. motor through either a worm or spur-gear reduction unit, because operating conditions prevented the installation of a belting system to the line. Inasmuch as the chain connection to the line should not be of more than 5 or 6 to 1 ratio, a speed of 50 to 60 r.p.m. would have been required on such a line. At 60 r.p.m., the result of a 6 to 1 chain ratio, a 3-15/16-in. shaft would be required to transmit 35 hp., a condition not practical when direct connection was possible.

Based on the construction of the mills in question, it was possible to install on the top of each, a 10-hp. motor flexibly coupled to a 38 to 1 ratio spur-gear reduction unit which in turn could be direct connected to the mill by means of a finished steel roller chain. This system was applied to each mill, as shown in Fig. 1, resulting in an efficient method of driving, and in this case a cheaper one from the standpoint of initial cost.

New mill No. 3 required additional material fed to it slowly. This operation was accomplished by the installation of a screw conveyor which could easily be driven from the old group line through a roller chain clutch controlled to a countershaft bevel gear connected to the conveyor.

Massive, new, slow-speed grinding machinery was installed in that section of the building which had been cleared of old apparatus. Because of the construction of these grinders and the operating conditions surrounding them, it was not possible to direct connect them through gear reduction units from above or below. Clear space around this machinery was necessary; therefore, it was evident that a suspended line shaft would have to be employed, and which would have to operate at slow speed because of the required 20 r.p.m. of the grinders.

A 2¼ to 1 ratio was used on the chain connection from the line so as to obtain the highest speed possible. At 45 r.p.m., however, it was necessary to use 2-15/16-in. nickel steel shafting to transmit safely the required 20 hp. This group line could not be driven by the belting system as were the other group lines in the building because of the unalterable brick partitions on both ends and the existence of an operating platform. The problem was solved by the installation of a 20-hp. motor, flexibly coupled to a 25 to 1 ratio spur-gear reduction unit which in turn was rigidly coupled to the line shaft. The grinders were driven from the line through finished steel roller chains, clutch controlled.

It is seen from the foregoing analysis that the results were obtained through the use of modern equipment which is adaptable to almost any transmission requirement. Methods and mechanisms of the present make possible the solving of driving problems economically under unfavorable conditions that would have been next to impossible before the advent of group systems and direct connection through flexible couplings, reduction gears, and chains.

Individual driving problems, not necessarily brought about by a rearrangement of equipment, are of frequent occurrence in many plants. The installation of a piece of apparatus of new design can cause serious disturbance to the existing transmission layout because of required location, method of power application, and speed. In view of this, it is often necessary to resort to forms of equipment that are known to be heavy power consumers.

A typical example of such a case is shown in Fig. 2. It was necessary to transmit power to the pulley shown, from the side shaft at 90 deg., and the universal coupling was used, which in the emergency solved the problem. Bevel or miter gears could have been employed if sufficient space had been available. The universal coupling at 90 deg. is not efficient from a power standpoint, but at slow speed it solves complex problems of this character.

In the article published in the April, 1930, issue of *Industrial Engineering*, "Power Drive Analyses — Conditions Favorable," it was mentioned that modern screw machines were usually individually motor driven to overcome the twist in the vertical belt caused by the necessity of placing such machines on an angle. It may happen, however, that a production plant must add a battery of belt-driven screw machines to its equipment. If they are to be driven from a group line through a countershaft, the universal coupling can be used on the countershaft to advantage. It can be placed on this shaft in such a manner as to eliminate the twist in the belt from countershaft to machine. Although it is a power-wasting installation, the loss is compensated for by decreased belting maintenance. The countershaft can be straight belted from the line, and the machine straight belted from the countershaft because the universal coupling on the countershaft allows for the angular requirements.

It is difficult to compare the driving problems of a process manufacturing plant with that of a machine-part production plant from the standpoint of unfavorable conditions because the set-up and kind of machinery are so vastly different. In the former, practically all apparatus must coordinate as to speed and motion, whereas in the latter each

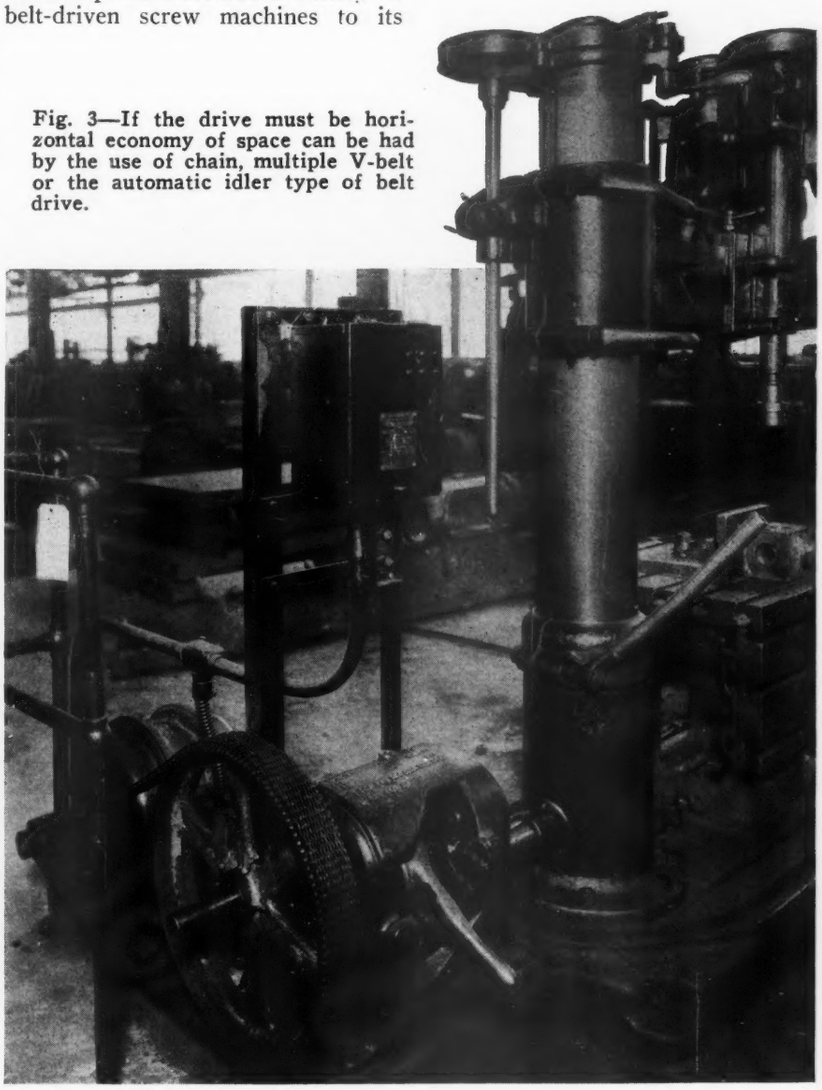


Fig. 3—If the drive must be horizontal economy of space can be had by the use of chain, multiple V-belt or the automatic idler type of belt drive.

machine tool is an individual producer regardless of the fact that frequently such tools are arranged in batteries. It is seldom that complex driving problems arise.

In a production machine shop it is usually a question of group or direct driving—a problem generally solved by the class of tools involved. If a rearrangement of existing tools is necessary, the belt-driven type can be moved and connected to a different group line, and the direct-driven class can be relocated as a unit. If new tools are to be placed among existing ones, space must be provided on the line shaft for belt-driven units and floor space provided for the direct-connected tools. It may happen, however, that certain tools require individual driving but are not designed for integrally connected motors. Such a condition requires a motor independent of the machine and either belt, chain, gear, or multiple V-belt connected. If the drive must be vertical, a belt with take-up facilities is preferable, but if horizontal, economy of space can be had by the use of chain, multiple V-belt, or the automatic-idler type of belt drive.

An example of such an installation using the silent chain as a driving medium between a motor and a radial drill is shown in Fig. 3. Owing to the rearrangement or the elimination of certain tools, it often occurs that a motor driving a group line can be dispensed with because of the possibility of one existing motor driving two lines by means of a cross connection. An installation of this character is good practice from a power cost standpoint.

A Plant Engineer Looks at MAINTENANCE

By C. H. WHITE
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Plant maintenance is always bringing up new problems, and precedent is often lacking. Good judgment and thorough analysis are after all the only guides to a plant engineer's work. The writer, therefore, in presenting the following, does not attempt to define the duties of a plant engineer. It is rather a summary of what he has seen in his own work; and any ideas expressed are taken from these experiences, or from those of men with whom he has worked.

THREE vital phases of industry are served by the plant engineer: Housing; controlling the supply of energy through the plant; and transportation within the plant. Under the heading of housing are included the care of buildings such as keeping roofs, windows, walls, and floors in repair; and maintaining the heating and lighting of the buildings. The second item, energy supply through the plant, is somewhat broader in its scope. One division is the care of power lines including steam, electrical, hydraulic, and compressed air. Another division includes the transmission of mechanical energy from these lines to the production tools. For instance, in a shop processing pressed steel, this service would constitute care of motors, lineshafting, belts, and presses, but not the dies. Under the heading of transportation within the plant come tractors, cranes, lift trucks, and conveyors.

New equipment, whether buildings or machinery, also must receive its share of attention. However, this is often a subject which must be worked out in conjunction with the management and the production departments. For this reason, and because of the fact that plant layout, particularly as regards suitability to specialized manufacture or processes, has already been given a fair degree of attention in the technical press, this article will deal largely with the subject of maintenance.

Care of structures is extremely important. A good building may be practically ruined by a few years' neglect. Roofs, in particular, should receive constant attention. During rainy weather, the plant engineer should make it his duty to go the rounds looking for evidence of leaks. Locating leaks is not always an easy task. Many times, as in the case of an old roof that has been patched, a leak may originate in a faulty lap of paper or tin some distance from the place where it shows on the ceiling below. Periodic inspection will often bring to light breaks that should be patched immediately. A fruitful source of trouble is often found in valleys, or in flashing around monitors or penthouses, where the paper, in being bent around corners, has drawn away from the structures, leaving a void beneath it. A similar condition occurs in warm weather when air pockets form unser the paper, causing lumpy places. Workmen often step on these places and make breaks in the roofing.

On old buildings with flat roofs, pent houses or monitors are often built for the purpose of obtaining

increased headroom or light, and ventilation, with little regard being given to drainage. This will allow the formation of pools of water which, if allowed to stand, will impair the weather-resisting properties of the roof, or even affect its safety. It is not always feasible to relocate the downspouts to correct this condition, as doing so may entail the laying of new sewer lines. In such cases, a false roof may be built up, creating a slope to the nearest downspout.

Every three or four months, the roofs should be swept of refuse and fine grit or soot which will collect in corners and flat places. This refuse, if allowed to accumulate, may cause a complete stoppage of the downspouts. Badly neglected roofs will often be found to have several inches of dirt on them. When rain-soaked, the weight of such an accumulation will approximate a very considerable snow load.

The degree of care to which windows are entitled varies, of course, depending on what the building contains. In structures housing fine or light machinery, or perishable goods, they should receive the same care as those in an office building or residence. In steel-mill buildings, heavy-structural, or stamping shops, however, this attention would be unwarranted. The glazing in such cases should be of wire glass, so that even a hard knock will not cause the glass to fall out. Special care must be taken to keep all the windows tight in buildings furnished with sprinkler protection, in order to prevent freezing of the water lines. In cold weather, a single broken pane may result in a disastrous delay in the operation of the sprinklers.

Windows, whether of the obsolete wood type or of modern steel, should be kept painted. Wood sash rots quickly if neglected, and is not worth repairing. If it cannot be replaced, about the only thing to do is to paint it with a thick tar paint and hope that the wind will not blow too hard. In no place is the air more corrosive than in the smoke-laden atmosphere of a manufacturing district. The early type of steel window, made of sheet steel, is quickly rusted through, however, the more recent type of steel sash, made of rolled-steel bars, is the most durable for factory purposes. It would take several years of neglect to rust them badly; and if they are kept painted, they will last almost indefinitely.

Sheet steel or wood walls must, of course, be kept painted. Here, too, attention must be given to keeping the structure weather tight and free from draughts in winter. Special care should be given to cracks in brick walls. The collection of moisture in such fissures, and its freezing and subsequent expansion, may result in eventual disintegration. It should be the duty of the building maintenance men to point all cracks in brickwork as soon as they are perceived.

Of utmost importance in any manufacturing plant is the condition of the floors. Since trucking often is a large factor in costs, it can readily be seen that a rough, bumpy floor may add greatly to the cost of transportation. Then, too, a rough floor contributes in great measure to accidents caused by the upsetting of trucks. If much heavy trucking is being done, concrete or wood block floors are advisable. Concrete flooring should be covered with some bituminous preparation or treated with a hardener or dust-laying preparation. Plain cement, once it is scratched by truck wheels, dusts and disintegrates rapidly.

Maintenance of machinery and equipment is of even greater importance than that of buildings. The production department does not recognize the failure of machinery as an excuse for delay in production. In such cases the question is always asked: "Why was the breakdown?" or "Why was the trouble not noticed and remedied before a complete breakdown occurred?" The maintenance department should be charged with the sole responsibility for keeping the machinery in order. It has been found unsatisfactory to depend on the production departments of the plant to report defective machinery. The men operating the machinery, with the possible exception of those who operate special types, do not always report trouble until it has developed to the point where the machine either slows up or ceases entirely to perform. By this time the machine may have become so badly damaged that costly repairs and a shutdown are necessary.

Every maintenance department

In a bay of the type shown, regular inspection is required to maintain roofs and windows. Overhead is shown a part of the heating system.

Improper floors and materials handling equipment in a department like this would add to the cost of inter-plant transportation. Rough, bumpy floors would contribute to accidents caused by upsetting of trucks.

Material and personnel must be protected from the weather. Keeping the structure weather-tight is the responsibility of the plant engineering department. Much valuable semi-finished material would be seriously damaged if there were leaks in this roof.

should follow a policy of rigid daily inspection of all machinery in operation. This work can be carried on in small plants by the master mechanic, or in larger plants by several of the more experienced millwrights. In few cases need this take up more than an hour or two each day, and the time will be found to have been well spent. The inspector should be equipped with a few tools; and any minor adjustments, such as tightening loose bearing caps or unclamped pitman screws, can be effected with but a few minutes' loss of time. If the machine is found to be in such condition that more extensive repairs are necessary, the fact should be noted and reported immediately to the department head and to the head of the maintenance department, so that it can be scheduled for repairs. If it is impossible to remedy the defect immediately, temporary repairs can be made, the machine watched carefully and replacement parts ordered, so that it can be fully repaired at the first opportunity. Temporary repairs, however, should be avoided as much as possible, as the work all has to be done over again on the permanent job.

The most fruitful sources of trouble in machinery are over-loading and insufficient lubrication. The former is usually directly traceable to the production department. The plant engineer, however, can control this to a large extent by seeing to it that the department heads are informed as to the capacities of the machines in the shop. If, for instance, a new press is bought, the manufacturers' data sheets should be obtained, and the information from them passed on to the engineering department if it does not already possess that information. Furthermore, it should be the duty of the plant engineer's office to prepare a map of the entire plant, showing the location of machines, with capacities noted on them.

Lubrication is a function of the millwright department. As this is a very important duty, responsibility for its performance should be definitely fixed upon certain men, each of whom is assigned a certain group of machines to care for. If the machines are in constant demand, and are of such size that considerable time is necessary to lubricate all wearing surfaces, some centralized system of lubricating should be installed.

Every plant, regardless of its size, should study the possible economies that might be anticipated from the use of purchased power, providing it is available. The duties of the electrical department are practically confined to the care of electrical machinery and power transmission. No one but a member of that department should be permitted to perform work on electrical equipment, as such work requires specially trained men.

A condition often overlooked in making plant extensions is the overloading of power circuits. Even where this is not done to the extent of creating a fire risk, the loss in efficiency that occurs through voltage drop is oftentimes more than enough to pay for increased current-carrying capacity. Another point to be watched in the interest of electrical efficiency is the power factor. If it is low, owing to the intermittent operation of large inductive units, it can be offset by the employment of

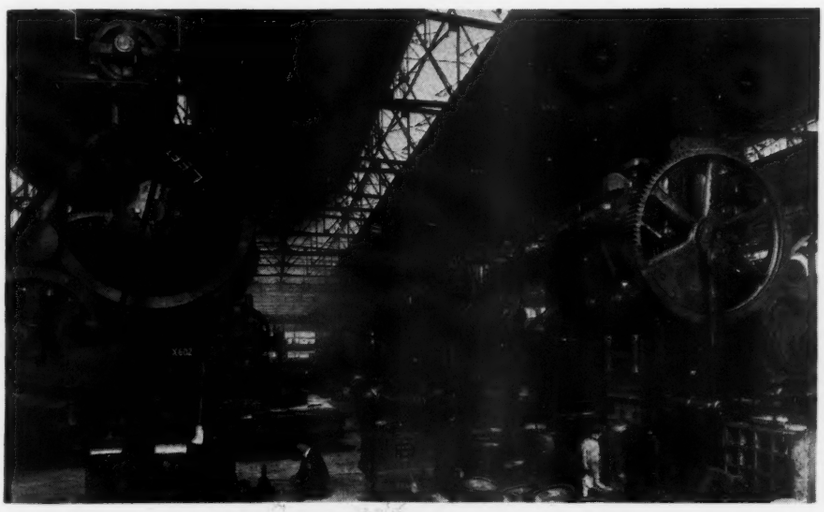
suitable corrective devices such as synchronous motors or static condensers.

Maintenance costs are probably the most elusive of all manufacturing accounts. There is a tendency to regard the maintenance department as a kind of standing army. The difficulty of this conception lies in the fact that it is hard to determine just how large this corps should be. It is possible to schedule maintenance jobs just as production jobs are scheduled, and to have an idea of approximately what is being spent from week to week. When a machine is found to be in need of repairs, the plant engineer is immediately notified. If the item is small, say under twenty-five dollars, he immediately issues orders authorizing the work.

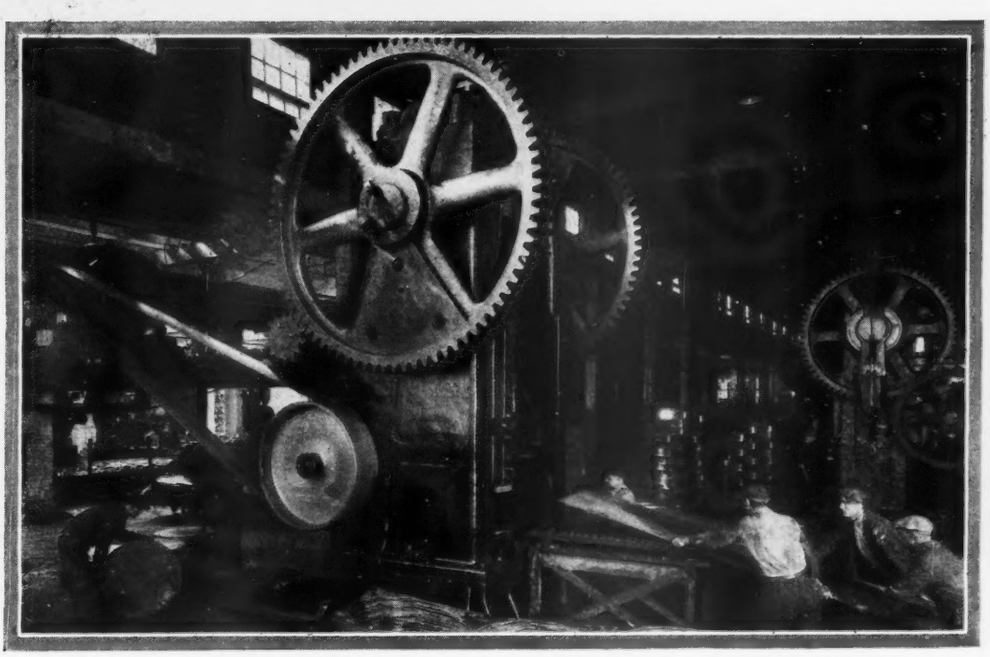
If, however, considerable work is necessary, an estimate of labor and material must be prepared. An order is then written requesting authority for the expenditure. This is signed by the plant engineer and the manager, and a number assigned to it. All work done on the job is then charged against this number. Through the time-keeping department, the plant engineer's office is furnished with a daily report of the time spent on the job. If a job is found to be consuming more man-hours than were assigned to it in the estimate, an investigation is made to see whether this overrun is the fault of the millwright crew or the original estimate was too low. Sometimes the machine, when dismantled, shows need of repairs not at first apparent. An order is then made out requesting the additional expenditure necessary. This must then be signed as was the original order. By keeping time records of each job, the cost of future repairs of similar nature can be closely estimated.

For most practical purposes the maintenance organization should consist of three main groups: the millwrights, the construction department, and the electrical department. If the nature of the plant is such that there are no machine tools or tool shop, then a machine shop should be included. With the exception of the electrical department, at least a portion of these crews should be able and willing to work in one department or the other in order to reduce labor turnover.

A question often raised is, "When should outside contractors, employing specialized workers, be called in on a job?" Many factors enter into determination of the answer. Machine repairs, because of the usual urgency in such cases, should ordinarily be taken care of inside the plant. Closer cooperation can usually be obtained between the production department and the maintenance department in this way. An exception would be in the case of an unusually heavy job, requiring a number of men, or where special machinery is involved. Extensive building repairs or new construction should, in most cases, be handled by outside contractors. Very large plants, or plants located in isolated communities, frequently find it necessary or profitable to handle a large part of their construction work themselves. In large communities, however, it will usually be found advantageous to rely on outside sources.



Continuous production is predicated by intelligent maintenance of equipment. With new tools, particularly large toggle presses as shown, damage can be circumvented if the operations are kept within the rated capacities of the machines.



Where the services of machines are in constant demand, and the machines are of such size that considerable time is required in lubricating wearing surfaces, some centralized system of lubrication should be installed.

AROUND *the* WORKS

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

Why the Heater Failed to Work

WASHING machines for cleaning metal parts are quite common in automotive plants. Recently, one of these machines was installed to operate on one-pound steam pressure with a vacuum on the condensate side of 10 in. of mercury. Immediately trouble was experienced. The machine failed to heat. Steam seemed to be plentiful up to the coil, but the coil was practically cold.

An examination of the heating system of this washer disclosed that the pipe fitters had installed a copper coil of sufficient size to heat the water, but the condensate line from the trap on the discharge end of the coil to the main condensate-return line dropped down 14 in. to a trench in the floor, continuing in the trench for a distance of 16 ft., and then up again for a distance of 2 ft. to the main return line.

Obviously the water was not being lifted out of the ½-in. line between the trap and the main return line, so that the copper coil in the washer became waterlogged. The solution was quite simple.

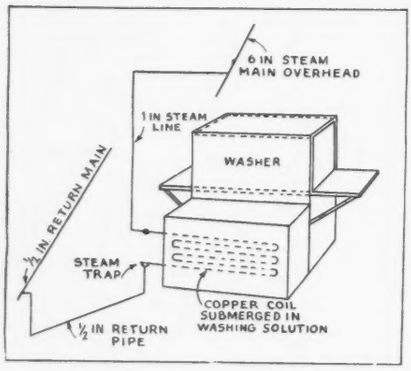


Fig. 1—Details of piping for the metal washing machine. The condensate return to the main is shown at the lower left.

A so-called lift fitting was installed at *A* as indicated in Fig. 1, and constructed, as shown in Fig. 2. Here it is shown made up of a 2-in. tee having a standard bushing in one end to receive the pipe connection to the return main. This piece of pipe was given a long thread and screwed into

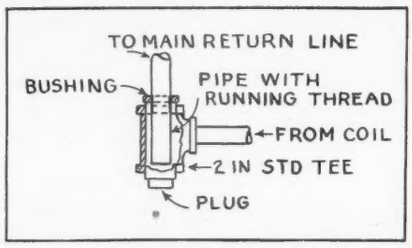


Fig. 2—A lift fitting devised to remove the condensate from the return line. It was installed at *A*, as indicated in Fig. 1.

the tee so that the lower end is below the right-angle pipe from the coil, and therefore submerged during the time that the coil is condensing steam. The condensate is now easily removed from the line, and the coil functions perfectly.

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Step-by-Step Method Locates Source of Vibration

A PECULIAR case of vibration was found in the floor of a balcony on which was mounted a motor-driven welding generator, and the welders' work table.

Supported on "I" Beams, the 2-in., yellow-pine floor apparently was good for several times the normal loading, as it had been built to be used as a storage space. The m.g. set was well balanced for a machine of its rating, but trouble had been encountered, that is, breakage of ball bearings owing to excessive vibration. Also the welders' table would vibrate sufficiently that the work would move about. The set was located near the wall, while the table was near the center of the space allowed for the welding work.

Oftentimes the vibration would build up in amplitude until it was necessary to shut down the machine. This interruption took an hour or two from the time of operating and it varied greatly on different days.

While watching the operation one day, I shifted my weight from one foot to the other, noticing that the vibration had ceased, but on shifting back to the other foot again, the vibration was resumed. Apparently, there was a tendency for vibration in the floor, and as the loading on the floor varied from day to day, it had the effect of damping out all or part of the vibration or to reduce it to such an extent that it did not bother the welding operator.

For this trouble the cure was found in moving the set to the ground floor, after which no more vibration was experienced.

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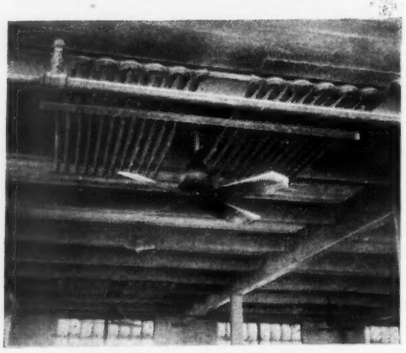
Dual Benefits from Single-Purpose Installation

NUMEROUS installations have been made where equipment has been provided for a particular function, and later on found to possess additional advantages beyond its original purpose.

Such an installation was found in the Conkling-Armstrong Terra Cotta Works, Philadelphia, Pa. where a drying system is used also as a cooling system. In this plant, there is a drying room in which clay forms are made and placed on the floor to remain until the mass becomes sufficiently rigid to retain its shape without the aid of supporting forms or molds. As the moisture is extracted, the clay becomes rigid enough to handle. Speeding up the rate of evaporation, therefore, speeds up production.

To expedite operations a drying system was installed consisting of over-



A close-up of a ceiling mounted steam coil with its ventilating fan.

head-mounted steam coils, and ventilating fans of the four-blade type shown in an accompanying illustration. These steam coils rest upon ¼x1½-in. angle iron suspended from I beams. A short section of pipe in the center coil gives them the appearance of two units, but its real purpose is to provide an opening for the fan post and to accelerate the flow of heated air from the ceiling by having the space free from obstructions. The coils are

One side of the drying room showing the arrangement of fans and steam coils.

made up of 24 pieces of 1¼-in. pipe cut to a length of about six feet.

There are 16 fans and half as many steam coils installed in the room, which is about 40 ft. wide and 150 ft. in length.

When drying operations commence, the steam is turned on and the fans are placed in operation at one of the three speeds obtainable. In winter when the building is closed the circulation of heated air is from the ceiling through the coils to the floor, then to the side walls and ceiling and through the coils again. The work, being on the floor, is arranged to come in contact with the air in circulation, and by controlling the speed of the fans rapid drying, and consequently cracking of the form, is avoided.

In summer when the building is open to condition the atmosphere for the workers, the fans, although handling heated air, serve to change the air rapidly and thus make the working conditions bearable. It was not intended to have the fans condition the air for the employees, nevertheless, aside from their original purpose they do just that.

Cut and Try Method Used in Paralleling Three Generators

RECENTLY a new 100-kw. 250/275-volt d.c. generator directly coupled to a 150-hp. synchronous motor was added to our generating plant. The previous installation consisted of a steam-driven generator, a 215-kw. motor-generator set, and a 300-kw. water wheel driven generator. However, with the addition of the new m.g. set the steam-driven unit was found unnecessary and was discarded.

In many instances it was necessary to operate the original equipment in parallel, and soon after the 100-kw. set was in place, we endeavored to parallel it with the 215-kw. set, as the name plates showed that the no-load and full-load voltages were the same. At no load both generators functioned normally, but when a 100-hp. load was thrown on the busbars the voltage of the 100-kw. set rose rapidly, and a few moments afterwards the circuit breaker on this set kicked out. A high-pitched noise at the brushes of one of the generators was heard just before the breaker opened.

However, the breaker between the 215-kw. generator and the busbars did not open. On investigation, reversed fields were found on this machine, so after the field polarity had been changed another attempt was made to parallel the two machines, but, with the same result. Over compounding on the part of the 100-kw. generator was found to be responsible for the trouble, so a shunt across the series field terminals was decided upon. Several strips of nichrome ribbon, 1 in. wide and 0.020 in. thick, were prepared, and 8 of these strips were placed in parallel across the series field. This additional resistance did not entirely eliminate the difficulty except at light load. A piece of 2/0 cable, 24 in. long, was then placed across the series-field terminals, but on heavy load the 100-kw. machine would not take its share of the load. By adding a plain iron washer, that is, placing it between the terminal of one side of the series field and one of the terminals on the 2/0 jumper, everything functioned properly, each machine taking its proper share of the load.

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Improvised Gang-Coil Winding Head Saves Winding Time

IT is common knowledge to all winders that in most semi-closed slot induction motor stators there are no soldered joints between the individual coils of a pole group. The reason being that the coils were made in a gang mold or on a winding head on which a group (usually three or four coils) were wound side by side without cutting the wire. This method represents a saving in winding time in addition to the time saved by omitting soldered joints.

Small repair shops that are not equipped with up to date coil-making machinery usually employ a wood form or else wind on nails driven in a board or improvised wooden rotating winding head making one coil at a time.

On the winding head described herein, coils may be produced to match factory-made coils. It is so simple to make that the time saved on one or two rewind jobs would pay for its construction.

As shown in Fig. 1, two 1x12-in. boards are nailed cross grained, at the corners. A discarded automobile steering wheel and shaft is secured thereto, the shaft being inserted in the headstock spindle of a lathe when coils are to be wound. However, the rotating is done by hand with the one long stud shown at *A*.

All studs were cut from the 5/16-in. control rods of the same car. The spacers, *B*, were cut from control rod tubing (as used in hollow steering wheels on large cars), and which must easily slip over the 5/16-in. studs. These spacers should be cut off in a lathe as they ought to be faced and of uniform thickness, the coils to be wound determining their thickness. For the spacing washers, *C*, plain 5/16-in. steel washers will do, if they are straight.

If no ready-made substitute can be found, the collars *D* can be made from brass rod, drilled and tapped for 8-32 or 10-32 machine screws. These collars should slip on the studs easily to save time in removing and replacing them.

In drilling holes for studs *A*, care should be exercised to have them parallel, otherwise the coils will be difficult to remove.

In use, the winding head can be held in a lathe, as in Fig. 2, or by means of a simple arrangement, as in Fig. 3, it may be mounted on a workbench. In this case, a discarded transmission shaft from a common type of car was found to be ideal for mounting other coil forms. A long board on which skein coils can be wound between two spools can be attached, instead of the winding head.

At *E*, in Fig. 1, is a small pin (or large nail) over which the last turn of each coil is hooked just before starting the succeeding coil in its form at spacer

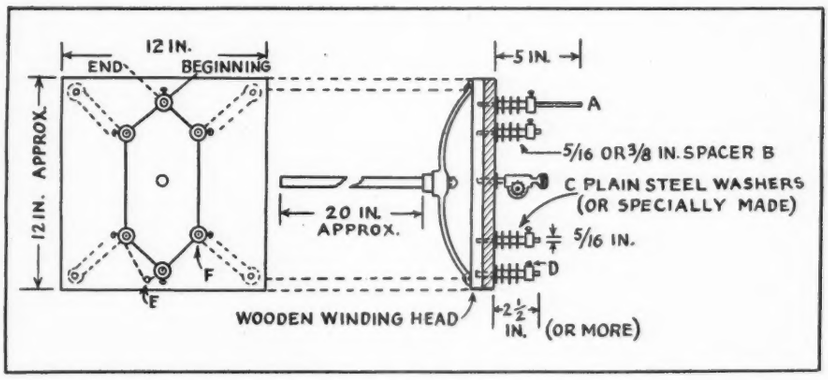


Fig. 1—Plan and side view of the winding head which is rotated by means of stud *A*. Turns are counted by means of a revolution counter held as shown.

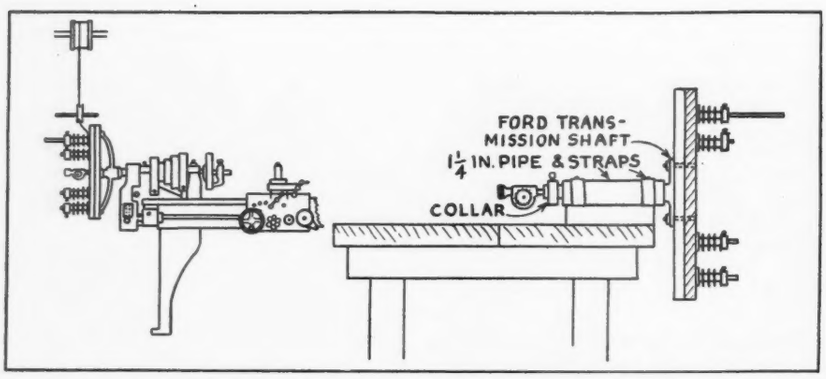


Fig. 2—How the winding head is held in a lathe.

Fig. 3—The winding head mounted on a workbench.

F. This spacer provides the separation required when the coils of the group are installed. Pin *E* is pushed out even with the last coil when finished and should fit snugly. The leads between coils can be on the connection end, however, leaving them on the opposite end, as in Fig. 1, simplifies testing and cutting out coils later (assuming that they may otherwise be concealed by jumpers).

Coils, of course, are tied on both sides before removal by pushing string around the coils with a piece of tin, after which the collars are loosened, the entire assembly removed, and spacers and washers caught in a box held underneath.

Turns are counted by means of the revolution counter held as shown.

J. P. KINCAID.

Kincaid Electric Company,
Colorado, Texas.

Guarding the Switchboards About the Plant

IN every industrial plant, there are one or more electric switchboards somewhere. In larger plants there may be, in addition to the boards in the power house, dozens of switchboards for transformer substations, motor-generator sets around the plant, electric dynamometer sets, synchronous condensers, static condensers, and so on.

In several plants I have visited recently, I was surprised to note the slight consideration paid to these scattered substations. Over here is a switchboard belonging to a motor-generator set installed as a synchronous condenser for power factor correction. It is a nice-looking outfit, but when I examine the switchboard I note that no steps have been taken to guard it: much of the panel is live front, and the back is wide open. Anyone coming in contact with the live parts would be burned badly, if not fatally—and yet it is such a simple matter to guard such boards and make them absolutely safe and inaccessible to everyone except an authorized electrician.

Grillwork designed for this purpose is standardized and may be purchased to fit almost any installation. Besides being exceptionally neat, it provides the necessary protection for employees and makes possible authorized control to insure continuity of service. Tampering with the rear of a board protected by a screen, is avoided. The usual weight is No. 13 gage expanded metal mounted on an adequate framework and provided with a door which is standard and may be located at any point without throwing the job into a special class.

Although these guards are usually finished in black japan, they may be obtained in other colors. Some plant engineers prefer to have their equipment painted with a gunboat grey enamel, in which case the grillwork should be painted the same color, indicating that it is a piece of equal value with other equipment. Others prefer to put the grillwork in the class of safety guards and paint it a special color.

H. C. CHARLES.

Waterloo, Iowa

Stuffing Boxes for Motor Drive Through Firewall

SOMETIMES it is necessary to carry a shaft through a firewall and seal it against the passage of flammable vapors, as where a city ordinance calls for a firewall between the motor and pump used in gasoline loading plants. In such cases, a stuffing box to carry the shaft must be provided. This box usually is furnished with the equipment and consists, as shown in Fig. 1, of a cast-iron plate with a gland spit in two halves.

To secure this stuffing box in the wall, which is usually of hollow tile, a space is left about 24 in. square. In this space a piece of ½-in. boiler plate, cut square as shown, is placed. This plate has holes drilled and tapped in it to make up with the holes in the cast-iron stuffing box. Studs are screwed into these holes and the plate is then put in place on the shaft and in the hole. Next, the stuffing box is secured to the studs and set up flush with the wall. A core is made the size of the coupling, to facilitate withdrawal, and grout is poured into the hole in the wall.

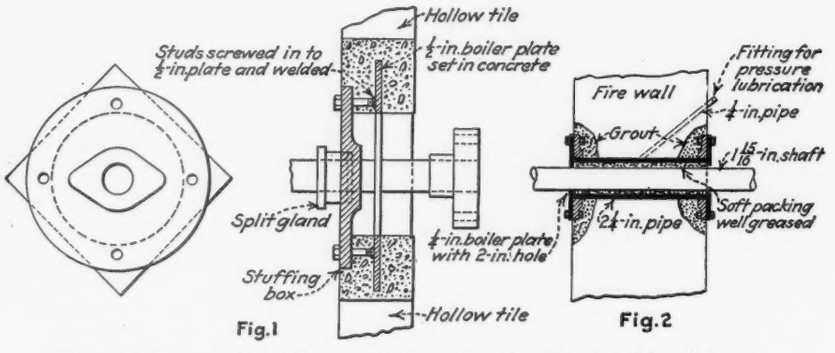
In this way, the stuffing box can be taken out by removing the nuts and sliding it along the shaft. To draw the motor or pump, all that has to be done is to slack off the coupling bolts and withdraw the shaft through the hole, leaving the boiler plate which carries the studs imbedded in the concrete.

Where no stuffing box is provided, a simple one can be made as shown in Fig. 2. Assuming that the shaft is 1-15/16 in. in diameter, a hole is cut in the wall to take a 2¼-, or 2½-in. pipe spool flanged at both ends. The bolts are welded at the head into the flanges so that they cannot turn. The motor is set up, and the shaft placed through the pipe. The space between shaft and pipe is filled with a soft, well-greased packing.

Two pieces of ¼-in. plate are cut round, drilled to take the bolts in the flanges, and then split. These plate serve as glands to hold the packing in place. A ¼-in. hole is drilled in the pipe and a ¼-in. pipe with a ⅛-in. fitting for pressure lubrication screwed in at an angle. The flanges are set in the wall flush and screwed up tight, bedding into a grout poured in between them.

This method of sealing a shaft that passes through a firewall is employed on a gear-driven, reciprocating, general-service pump in a main terminal and runs steadily several hours a day without any trouble.

Mechanical Engineer, M. C. COCKSHOTT.
Hancock Oil Company,
Long Beach, Calif.



The method of installing a stuffing box furnished with a motor-driven pump is shown in Fig. 1. In Fig. 2 are given the details of a stuffing box that can be built in the shop.

Lighting Institute Opens in Chicago

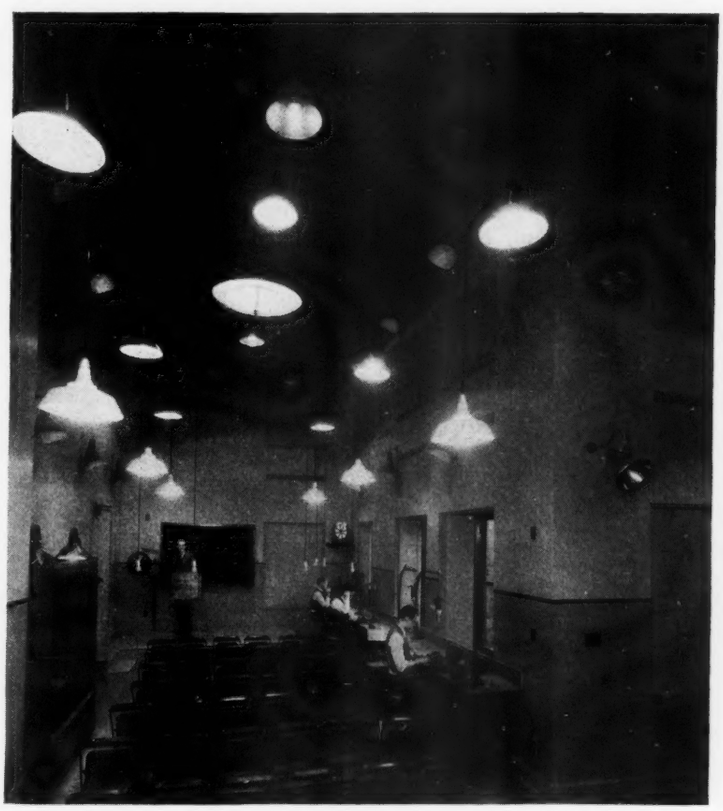
THE Chicago Lighting Institute, which opened during April, is in purpose an electric illumination laboratory for the Middle West. It is essentially a continuous demonstration of what modern artificial lighting can do for commerce and industry. Groups or individuals are invited to bring their lighting problems to the Institute where it is believed they will find practical solutions.

Equipment for the demonstration of all forms of industrial, outdoor, commercial, and domestic lighting, in completely furnished display rooms, is a permanent feature of the Institute. Each of these applications may be demonstrated over a wide range of intensities, colors, and forms. In addition to the demonstrations, installations, and equipment, the Institute has study rooms for classes in lighting theory, a theatre for lectures, conference rooms, and a lounge.

One of the two-story demonstrations—the industrial lighting room—should be of particular interest to the readers of *Industrial Engineering*. Here is a workshop where the visitor can actually work with tools at a bench to find out for himself the greater capacity he has for working efficiently under the best lighting conditions. On the 20-ft. ceiling are several industrial luminaires, adjustable as to height, degree of eye protection, diffusion, etc. Around the floor are arranged work benches, machine tools, a paint-spraying booth, and other equipment usually found in a modern industrial plant. Magnifying devices equipped with concealed lamps, intensifiers, projectolites, and special devices for silhouette lighting have been installed. Also on the ceiling are two 10,000-watt lamp units, each six ft. in diameter with which it is possible to flood the room to a value of approximately 400 foot-candles.

Special hangers and other lamp maintenance equipment are demonstrated, as are also the characteristics of different types of units and light directing equipment.

The Institute is sponsored by the following companies: Benjamin Electric Manufacturing Company, Byllesby Engineering and Management Corporation, Central Public Service Corporation, Commonwealth Edison Company, Curtis Lighting, Incorporated, The Electric Association, General Electric Company, Middle West Utilities Company, Midland United Company, North American Light and Power Company, Public Service Company of Northern Illinois, United Light and Power Engineering and Construction Company, Westinghouse Lamp Company.



A section of the Industrial Room at the Lighting Institute.

These Precautions Make Gasoline Safe

THERE are a few fundamental facts and precautions that should be borne in mind in the storage and handling of petroleum products in order to minimize the fire hazard.

Of all petroleum products, gasoline is commonly considered the most hazardous. A flame pushed into gasoline would be extinguished, as it would in water, providing the vapor at the surface was not ignited.

A mixture of sixteen parts air to one of gasoline, ignited by a spark, operates an internal-combustion engine. For this purpose the value of gasoline or other volatile fuels depends upon the explosive quality and they must, therefore, be given all the consideration due them.

A full tank, bottle, or other container filled with gasoline cannot explode, even if lighted, but a semi-filled container is dangerous. In all probability, it will have a mixture of air and vapor above the liquid, and this mixture is highly explosive.

Therefore, keep all fires away from any possible mixture of petroleum hydrocarbon vapors.

It is well to remember that gasoline vapor is heavier than air, and for that reason it sometimes remains in an empty container mixed with air. Consequently it is good practice to turn empty gasoline containers upside down for a while before putting them to other uses. Large containers should be thoroughly ventilated before any work is performed upon them.

It is dangerous to attempt to extinguish a gasoline or an oil fire with water. Its application causes these liquids to float on the surface, thereby spreading the fire. The proper method is to smother the fire. For a small blaze, a woolen blanket will do the work. Sand or dirt also answer the purpose in some cases, but for a large and persistent fire utilize an extinguisher of the type that smothers the fire.

Denver, Colo. H. L. KAUFFMAN.

CHECKING

Developed Winding Diagrams

for three-phase machines

By A. C. ROE

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PRECEDING articles in this series on changing obsolete windings have dealt with modifications in the type of coils used, reduction in copper length, types of windings, and so on. In the majority of cases, it was necessary to draw a new connecting diagram of either the line or developed type, for the improved winding. This article will describe the methods used to start and check developed winding diagrams for three-phase machines, as this type of diagram is likely to be troublesome.

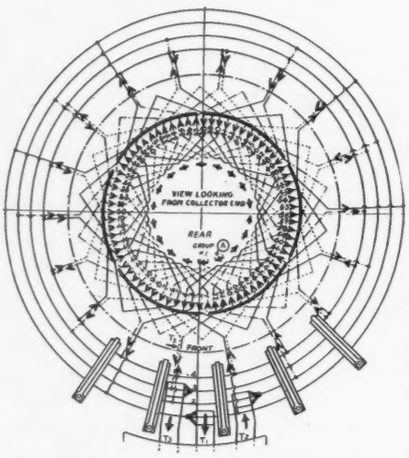


Fig. 1—Application of check No. 1 indicates a correct connection, although in reality phase T_1 is reversed; hence, the connection is wrong.

When the leads of the coils and cable are used for connecting the pole-phase groups together (that is, as jumpers) and for the star connection or leads, it is possible, and the general practice is, to use the simpler, straight-line type of diagram as shown in "Repair Shop Diagrams" by Braymer and Roe, published by the McGraw-Hill Book Company. When the capacity of the machine is great, it becomes necessary to use copper strap for the lead and star rings. The connections from the coils to these rings are also made from bare copper strap, and it is imperative that the location of these rings and special connectors be shown on a drawing. For machines of this type, it is customary to develop a winding diagram that shows the coils laid out with the correct pitch, and the pole-phase group leads and jumpers, with reference to the horizontal or vertical center lines of the stator.

A developed winding diagram is more difficult to check for errors, and care must be exercised in starting the phases in the right pole-phase group lead. Therefore, the diagrams and text of this article will give rules and short-cut methods for checking and starting developed winding diagrams.

The features of developed winding diagrams can be explained to better advantage by using one as an example for checking for improper

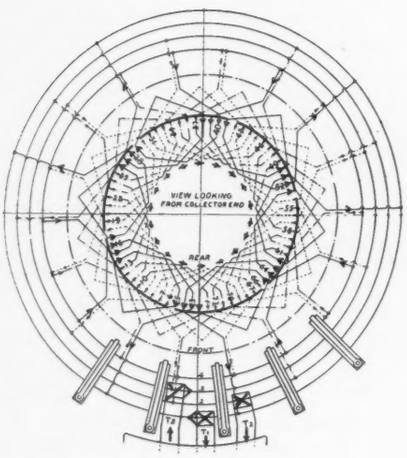


Fig. 2—Check No. 2 falsely indicates a correct connection.

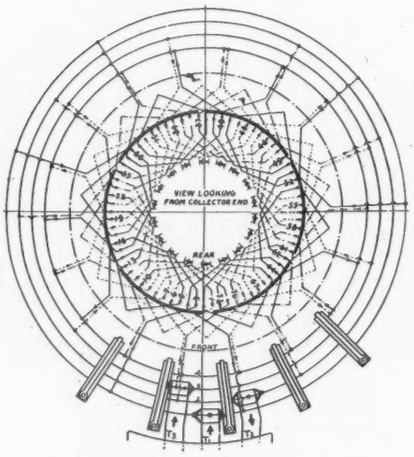


Fig. 3—Check No. 3 falsely indicates a correct connection.

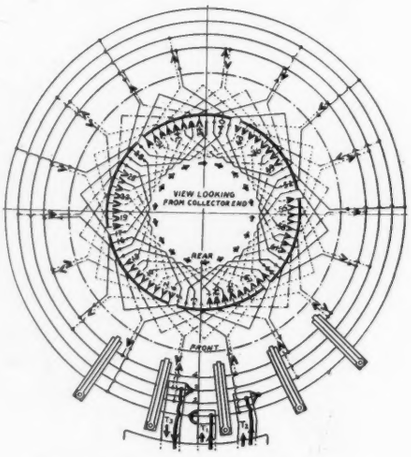


Fig. 4—Check No. 4 falsely indicates a correct connection.

phase relation, or a 60-deg. instead of the correct 120-deg. connection.

All developed diagrams have arrows on the coil sides to indicate current flow, and the line leads are selected so that the direction arrows point into the winding on two leads, and out on the other lead. This is termed the "two-in-and-one-out" check, and means that starting at any one line lead and following the winding through in the direction indicated by the arrow on the lead, the direction should also coincide with the arrows on the coil sides in all slots.

There is one drawback to the two-in-one-out check: that is, checking the winding once will not prove it correct as there are six possible checks, as shown in Table I, and only two of the checks will reveal the error. Table I lists the lead markings for the six checks possible with developed winding diagrams. It will be noticed that there are three two-in-and-one-out checks, and three two-out-and-one-in checks. By applying checks Nos. 1, 3, and 5 in the order given, an error should be revealed.

Fig. 1 is a developed winding diagram for a six-pole, three-phase, six-parallel star connection on a 72-slot, 36-coil, one-coil-per-slot motor, having 18 groups of two coils per group. The pitch is 1 and 12, four slots per pole per phase. Note the arrows in the slot sections and how they are divided into six groups, all of the arrows in each group pointing in the same direction, and that the arrows in the adjacent groups point in opposite directions. The four rings are the line leads and star, ring *1* being the T_1 lead, *2* the T_2 lead, *3* the T_3 lead, and *4* the star ring.

At *A*, Fig. 1, a straight line has been drawn to represent the group of two coils and the arrow shows the direction of flow, making Fig. 1 a combination developed and line diagram. This method provides a double check, as the two-in-and-one-out check on a line diagram gives three like groups together as shown, and provides a never-failing check, as will be explained later.

The connection shown in Fig. 1 is wrong as it shows a 60-degree relation between phases: phase T_1 is reversed and Figs. 1 to 6 inclusive show the six checks of Table I applied to detect the error. Fig. 1 shows check No. 1 which would indicate a correct connection, as do check No. 2, Fig. 2, check No. 3, Fig. 3, and check No. 4, which Fig. 4 illustrates.

In making these checks, ring 1 is started on first, and each pole-phase group is followed through in the direction indicated by the arrow in Table I. An arrow is placed on each coil side, as shown, and for a correct connection all six checks should result in six groups of twelve slots, each group having the arrows pointing in the same direction, and the adjacent groups of twelve with the arrows pointing in opposite directions. But each check will change the slot numbers in like groups; for example, in Fig. 1 slots *2* to *13* form one pole group with the arrows pointing away from the center. In Fig. 2 slots *66* to *5* form a similar group. Fig. 3 has slots *62* to *1* forming a like group, whereas Fig. 4 has slots *6* to *17* pointing away from the center.

Thus, when making the two-in-and-one-out or the two-out-and-one-in check, the arrows on the coil

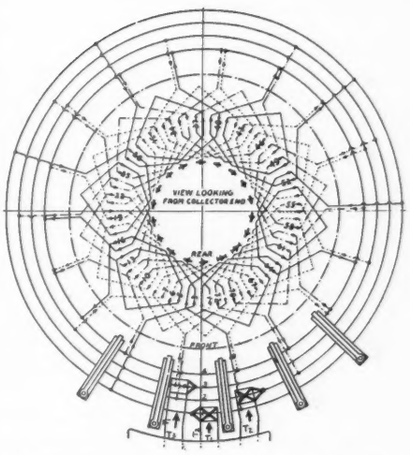


Fig. 7—The all-in check shows a wrong connection as the arrows on the line groups do not alternate on adjacent groups.

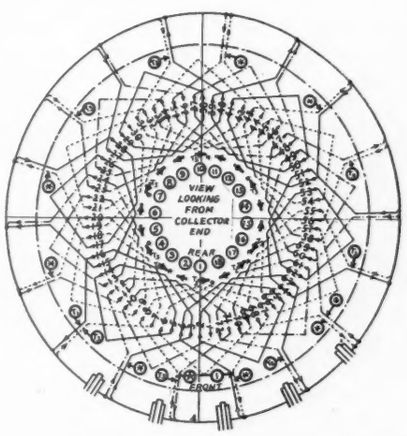


Fig. 8—Developed drawing to locate the wrong connection. The coils have been connected for the proper pole-phase grouping and a line drawn at the rear of each pole-phase group to represent the line-type diagram.

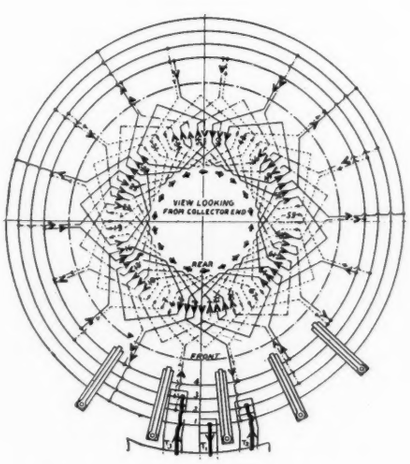


Fig. 5—Check No. 5 shows a wrong connection, as the slot arrows and line arrows are not grouped correctly.

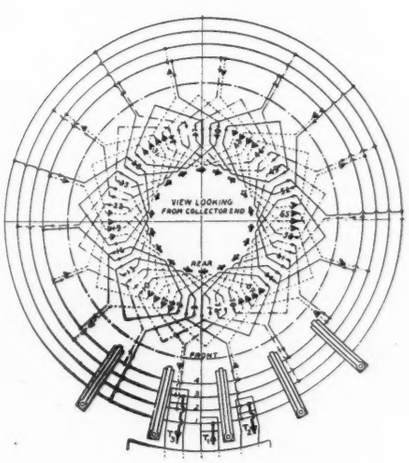


Fig. 6—Check No. 6 shows a wrong connection.

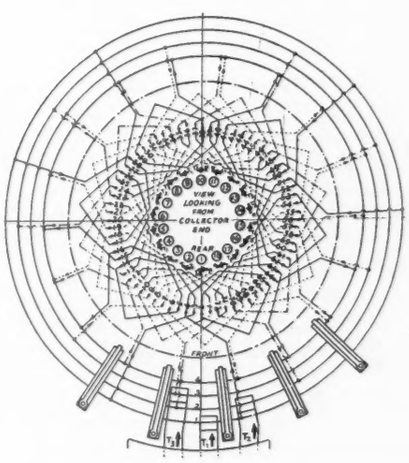


Fig. 9—The all-in check proves that these are the correct connections for a six-pole, six-parallel star winding.

sides should result in as many like groups as there are poles; there will be exceptions to this rule when the coil pitch is chorded beyond a certain point, which varies with the number of slots and poles.

A quicker and more positive method that eliminates the slot arrows, is to connect the first and last coils at the rear end of each pole-phase group with a straight line, as at *A*, Fig. 1. Then start on the group lead and put the arrow on the straight line in the direction in which you have to pass across the rear coil end. For the winding to be correct, all six checks must result in three adjacent lines having the arrows pointing in the same direction, the next three lines pointing in the opposite direction, and repeat.

Checks Nos. 5 and 6, Figs. 5 and 6, applied to the same winding shown in Fig. 1 indicate a wrong connection, as the slot arrows and line arrows are not grouped correctly: the line arrows alternate in direction on adjacent groups. Thus the lines are a positive indication of a wrong connection on developed winding diagrams and can be used in place of the laborious slot arrow check.

To make one positive check on a developed winding diagram, place the lines at the rear of each pole-phase group of coils, as shown in Figs. 1 to 6; then use the "all-in" check which, for a correct connection, should result in arrows alternating in direction on adjacent pole-phase groups. The use of lines and the all-in check is shown in Fig. 7, which represents the same winding as in Fig. 3. Note in Fig. 7 that the arrows on the line groups do not alternate on adjacent groups, but form groups of three which for the all-in check proves the connection wrong with one simple never-failing check.

It has been shown that the connection given in Fig. 1 is wrong, but we have not located the error. The following discussion will, therefore, describe how to locate the leads in their proper position, as these data can also be used to locate wrong connections.

The first step is to make up a table showing the slot numbers connected to each ring, as shown in Table II. Next, make up a developed drawing with the coils connected up into their proper pole-phase grouping, with direction arrows in the slots and the leads from each group brought out as Fig. 8 shows.

To permit easy checking, draw in the straight lines at the rear of each pole-phase group to represent the line type of diagram, as shown in the inner circle of Fig. 8.

To combine the developed and line diagrams, the direction arrows on the line diagram must be started in the proper relation to one phase of the developed winding. This can be done by using the phase that has the current flowing into the developed winding and has the group in a location suitable for bringing out the line leads in the desired position.

In constructing Fig. 8 we can refer to the winding shown in Fig. 1 for lead location and find that, with the slot arrows pointing in the direction shown in Fig. 8, group *1* should have the line diagram arrow pointing from left to right. Then, as the arrows alternate in direction on adjacent groups, we can put arrows on all line groups, as in Fig. 8. Referring to Fig. 1 we find that group *1* starts in slot *8*, and also that the lead from slot *8* connects to ring *3*. Thus, for Fig. 8 we can mark this lead T_3 and also mark as T_3 the start of the *1* group.

The end of group *1* connects to the star ring, *4*, and we can put a star at the end of this group, which ends in slot *67*. The first group leads are joined together, for reference only, by the line marked *A* at the front end of the winding in Fig. 8. Thus we have the diagram started and a simple rule permits the selection of the remaining five groups of this phase.

This rule applies to all line diagrams and is as follows: *Every third group (1 and 4) is an alternate pole of the same phase, or every sixth group (1 and 7) is a like pole of the same phase.* This means that groups *1, 4, 7, 10, 13* and *16* are all in the T_3 phase, and that groups *4, 10,* and *16* are alike, but of opposite polarity to groups *1, 7,* and *13*. Then, remembering that the current in the T_3 phase flows from the lead to the star, we can mark the line groups and the leads from the developed winding group.

This has been done in Fig. 8, as group *4* has a T_3 lead at the right and a * at the left of the group line, or group *4* starts in slot *7* and ends in slot *20*. Groups *7, 10, 15,* and *16* have been treated in a like manner, and Table III started.

A rule for starting the T_1 or T_2 phases is based on the fact that when the first phase starts on a top lead, the other two phases must also start on a top lead, and the other two phases can be started on the second group (1 and 3) on either side of the group that the first phase was started on.

Applying this rule to Fig. 8, we count over 1 and 3 to the right from group *1*, locate group *17*, and find that the arrow on the line diagram points from left to right. Then forgetting all rules of developed windings and adhering to the line diagram rule that the current flows into the winding from each lead and out onto the star, we can refer to Fig. 1 and find that slot *72* which starts group *17* connects to ring *2*. Thus, we place a T_2 at the left of group *17*

TABLE I—Arrow Markings for the Six Two-In-and-One-Out Checks

CHECK No.	LEADS T_3	T_1	T_2	Fig. No.
1	↓ out	↓ out	↑ in	1
2	↑ in	↑ out	↓ out	2
3	↑ in	↑ in	↓ out	3
4	↓ out	↑ in	↑ in	4
5	↑ in	↓ out	↑ in	5
6	↓ out	↑ in	↓ out	6

TABLE II—Rings to which Leads from Slots in Fig. 1 Are Connected

RING 1	2	3	4 (STAR)
Slot 3	Slot 71	Slot 7	Slots 11-12
Slot 4	Slot 72	Slot 8	Slots 19-20
Slot 27	Slot 23	Slot 31	Slots 39-40
Slot 28	Slot 24	Slot 32	Slots 59-60
Slot 51	Slot 47	Slot 55	Slots 67-68
Slot 52	Slot 48	Slot 56	Slots 15-16
			Slots 35-36
			Slots 43-44
			Slots 63-64

Six-pole, six-parallel star connection.
Even numbers are top leads: odd numbers are bottom leads.

TABLE III—Rings to Which Leads from Slots in Fig. 9 Are Connected

RING 1	2	3	4 (STAR)
Slot	Slot	Slot	Slots
15	71	7	11-12 19-20
16	72	8	27-28 35-36
39	23	31	43-44 51-52
40	24	32	59-60 67-68
63	47	55	3-4
64	48	56	

Six-pole, six-parallel star connection. Even numbers are top leads; odd numbers are bottom leads.

and on the lead in slot *72;* then a star is placed at the right of group *17* and on the lead in slot *59*. The remaining groups of the T_2 phase are *14, 11, 8, 5,* and *2,* and these can be marked as outlined for the T_3 phase.

The third phase, or T_1, is started on the second group (1 and 3) to the left of group *1,* or group *3,* and the line arrows followed, which makes the lead from slot *16,* T_1, and the lead from slot *3* the star connection. The remaining groups of the T_1 phase are *6, 9, 12, 15,* and *18,* as will be seen.

Thus by using the simple line diagram rules, it is possible to lay out a developed winding diagram and Fig. 9 shows the correct winding, as the all-in arrow check on the group lines proves it right. By filling out Table III from Fig. 9 and comparing Tables II and III we find that the connection of Fig. 1 had the T_1 phase leads reversed, or in Table II ring *1* had leads *3, 4, 27, 28, 51,* and *52* connected to it and the star connections from phase T_1 were *15, 16, 39, 40, 63,* and *64,* whereas the correct connection of Table III, Fig. 9, shows leads *15, 16, 39, 40, 63,* and *64* connected to ring *1,* and leads *3, 4, 27, 28, 51,* and *52* to the star or *4* ring.

Thus the first step in checking any developed winding diagram is to apply the all-in check and fill in the group lines and direction arrows at the rear end of the pole-phase groups. Then, if an error is present, apply the rules given for starting the combined line and developed winding diagrams, filling out tables similar to Tables I and II and comparing like rings until the error is discovered.

The rules given in this article can be applied to one- or two-coil-per-slot windings, but care must be exercised when checking developed windings for two coils per slot, where a chorded coil pitch will cause the phase belts to overlap.

Mill Supply Associations Adopt Industry Merchandising Plan

UNANIMOUS adoption of the suggested industry merchandising plan featured the triple convention held last month in Memphis by the mill supply associations. These associations, the National Supply and Machinery Distributors' Association, the Southern Supply and Machinery Distributors' Association, and the American Supply and Machinery Manufacturers' Association, were represented by more than 400 members.

As a means of aiding those dependent upon mill supply distributors for service-to-production equipment and replacement parts, the members in convention discussed ways and means of working out details of the plan; how the necessary facts needed are to be gathered, how these facts are to be put into the hands of manufacturers, distributors, and industrial users, what the cost will be, and how the necessary funds are to be obtained. A decision was reached to submit the plan when completed to all industrial distributors for a referendum vote.

About this plan the following comments were made:

"The results of the merchandising plan which has been adopted will prove most beneficial to the entire industry. Among other things, it will aid in bringing about still closer friendship and cooperation between distributors and manufacturers."—D. D. PEDEN, retiring president, Southern Supply and Machinery Distributors' Association.

"Industrial distributors of this country have a combined potential strength that needs doff its hat to no one, but, until that strength is applied with unity of purpose, the results obtained will be negligible."

—R. M. Gattshall

"During the past year a better understanding and greater spirit of cooperation has been developed between the distributor associations and ourselves. Obviously, this makes it easier to solve our mutual problems and adjust our differences.

"The merchandising committee has undertaken a 'he-man's' task in attempting to bring order out of chaos in distributing methods and policies. Its members have devoted much time, thought, and energy to the work assigned them and I hope their efforts will bear fruit."—D. C. JONES, president, American Supply and Machinery Manufacturers' Association.

"Distributors are rendering a service that is essential both to manufacturers and users. We constitute a most important link in the industrial life of this country by constantly making available to industry the various supplies required to help them operate."—H. H. KUHN, president, the National Supply and Machinery Distributors' Association.

"By means of questionnaires to the distributors of this country we found that the distributor has in his possession facts with which to prove that he is both economical and necessary, and that he is willing to put these facts into a common pool to be whipped into shape for use in a campaign to distributors' sales forces, industrial users, and manufacturers.

"The information brought to light as a result of the committees' survey among distributors was evidence enough that some definite plan of action was absolutely essential to put the distributor in his rightful place."—R. W. PROCTER, chairman, Merchandising Committee.

"The time has arrived when you are to be called upon to pass judgment on a suggested plan of action, which it is hoped will inspire a harmony of thought and co-ordinated action between distributors and manufacturers for the betterment of the supply business.

"Last year the American Association formed a merchandising committee. This committee was requested by manufacturers and distributors to try to develop a plan which would be helpful to this industry.

"After nearly a year's work, a tentative plan of action was outlined to a selected group of distributors. It was as a result of perfect agreement that the American Association's merchandising committee was augmented to take in distributors from the Southern and National associations as well as distributors who belong to neither association. These men, together with the presidents and secretaries of the three associations working ex-officio, have brought to you a program representative of their combined ideas.

"Most of us are acquainted with the program which will be presented for your final judgment decree, but, before we enter into debate, it seems perfectly proper to make an appeal to you for your best thinking for the whole industry. In this way each individual will gain most.

"It seems proper to call attention to your oft-expressed desire for combined, co-operative action so that you will hew to the line and not be shot off at a tangent on things which have nothing to do with the problem before you."—R. M. GATTSHALL, The Republic Rubber Company, Youngstown, Ohio.

In brief, the program presented on the industry merchandising plan follows:

"It was suggested to decide definitely the following:

"(a) Do industrial distributors want a co-operative program which shall have as its purpose the strengthening of their prestige with manufacturers and industrial buyers?

"(b) Do industrial distributors want a fact-finding body which shall gather the necessary information for the purpose and to supervise its dissemination?

"(c) Do industrial distributors believe this material should be of uniform nature in order to be effective?

"(d) Do industrial distributors have a desire to organize in a way in which this may be accomplished?

"When and if the foregoing questions are answered the committee respectfully suggests the following things for consideration, which may be properly and profitably done:

"(a) Manufacturers should sponsor a national advertising campaign to industrial users featuring the importance of the industrial distributor.

"(b) Manufacturers' representatives should personally carry the idea of the industrial distributor's importance to all distributors, their sales forces, and to industrial users.

"(c) Manufacturers should be encouraged to carry a line in all their advertising to the effect that their merchandise is obtainable from a local distributor.

"(d) Manufacturers should be encouraged to present the economic importance of the distributor to local Purchasing Agents' Associations.

"(e) Distributors should enter into the advertising and promotional campaign for the purpose of selling industrial users the idea of buying from industrial distributors.

"(f) The industrial distributor should train his salesmen on the economic functions of the industrial distributor, giving definite reasons why they may expect business from the industrial user.

"(g) Industrial distributors ought to encourage the presentation of the story of their economic importance to local Purchasing Agents' Associations.

"(h) Industrial distributors should sponsor a campaign to manufacturers setting forth the reasons why manufacturers should sell through distributors.

"(i) Industrial distributors should be encouraged to carry in all their advertising a uniform slogan which will get across the idea of buy it from the industrial distributor.

"We recommend the adoption of an industry slogan which shall be used by industrial distributors and manufacturers in all copy directed to the industrial user. The slogan should carry the idea: "Buy it from the distributor."—J. L. PITTS, Brown-Roberts Hardware and Supply Company.

Gear Manufacturers Elect Officers

B. F. WATERMAN, of the Brown and Sharpe Manufacturing Company, Providence, R. I., was elected president of the American Gear Manufacturers' Association at the fourteenth annual meeting in Cincinnati, early this month.

The other officers for the ensuing year are: E. W. Miller, Fellows Gear Shaper Company, Springfield, Vt., first vice-president; John Christensen, Cincinnati Gear Company, second vice-president; Warren Jones, Jones Foundry and Machine Company, Chicago, treasurer. T. W. Owen continues as secretary.

Four members were elected to serve on the executive committee for three years: A. F. Cooke, Gears and Forgings, Inc.; F. W. England, Illinois Tool Works; Warren G. Jones, W. A. Jones Foundry and Machine Company; and A. A. Ross, Westinghouse Electric and Manufacturing Company. H. E. Eberhardt, Newark Gear Cutting Machine Company, was elected an honorary life member of the executive committee.

The Hartford Special Machine Company, Hartford, Conn., was elected a member company.

Second Annual Illumination Conference

ANNOUNCEMENT has been made that the second annual illumination conference will be held May 26, 27, and 28, at the Westinghouse Lighting Institute, Grand Central Palace, New York City.

This conference is primarily intended for experienced illuminating engineers and sales managers actively engaged in lighting practice or promotional work in further developing the lighting market.

The program this year is largely devoted to lighting load possibilities and the modern trends in equipment. Symposiums on lighting practice will be features of the conference. Many prominent utility, manufacturing, and technical men will address the conferees.

No registration or tuition fees of any kind will be charged. Those desiring to participate are cordially invited to do so and to register their names directly with the Westinghouse Lighting Institute.

BOOKS FOR YOUR PERSONAL LIBRARY

Electrical System Handbook

By Clarence Herbert Sanderson, Assistant Electrical Engineer, the New York Edison Company. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Flexible covers, page size 5x7 in., 1167 pages, price $5.

WRITTEN particularly for students of engineering, operators, inspectors, maintenance and test department employees, this book is presented without the complications of higher mathematics. It is comprehensive and thoroughly practical.

There are 12 sections, beginning with a discussion of the fundamentals of electricity and following with a discussion of the fundamentals of design, construction and operation of generating and transforming equipment, and their application.

There are treated auxiliary electrical equipment, switchgear, switchboards, motors, generating stations, transmissions, substations, and distribution. The book contains also a general discussion on the protection of electrical apparatus, circuits, and systems. An entire section is devoted to the inspection and maintenance of electrical equipment. Engineering tables and definitions of electrical words and terms are included.

Forty Years with General Electric

By John T. Broderick. Published by the Fort Orange Press, Albany, N. Y. Cloth, 218 pages, illustrated. Price, $2.50.

HISTORICAL in form, this book is less a history than a series of first-hand sketches having historical importance. It describes the origin and growth of the General Electric Company, and traces its success to the spirit of its founders.

The subject matter deals with the outstanding achievements, both scientific and corporate, and features in an interesting, readable manner some of the early technical and business workers in that company, such as Steinmetz and Coffin, who contributed in such large measure to the upbuilding of the electrical industry.

Essentially, the content of this book is the story of a great corporation, presented with an entertaining biographical setting and atmosphere. Incidentally, it portrays a large part of the story of applied electricity from 1880 to the present.

Electric Wiring

By Albert A. Schuhler, Electrical Engineer. Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Second edition, cloth 5x7½ in., 380 pages, 305 illustrations. Price $2.50.

IN this work, the various branches of electrical wiring, such as bell, burglar alarm, electric light, telegraph, and telephone, have been divided into units. Each unit is composed of a systematic course and is subdivided into jobs or exercises which are treated by means of illustrations and descriptions. These jobs, in turn, are presented in a series of steps, proceding from the simplest problems or principles to the most complex. Following the discussion of each subject or unit are a number of questions designed to insure a thorough understanding of the principles involved.

The purpose of this volume is to present in an easily understandable way the essential facts and principles underlying electric wiring for different types of equipment except power apparatus. It has been designed for use in vocational and trade schools, and for service men and others who may wish to pursue their studies independently.

Direct Currents

By Carl Edward Magnusson, Professor of Electrical Engineering and Director of Engineering Experimentation, University of Washington. Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. 495 pages, 6x9 in. illustrated.

THIS book presents in logical order the basic principles of the electric circuit and the characteristics of d. c. electric machines, apparatus, and distribution systems. Combined with the companion volumes on "Alternating Currents" and "Electric Transients," it forms a series or set of electrical engineering texts, covering the fundamental laws of electrical phenomena as applied to practical electrical engineering problems.

The subject is covered in 22 chapters, to which is added an appendix, outlining the treatment for electrical shock. Chapter I is devoted to an introduction of the subject in order to acquaint the reader with clear and precise concepts of the basic laws of the electric circuit. The term "electric circuit" is here used in a broad or general meaning and, therefore, includes magnetic and dielectric circuits and fields as coexistent and essential phases of the current flowing in the electric circuit. Other chapters treat of the magnetic properties of iron and steel, motor and generator characteristics, commutation, electrolytic conduction, transmission and distribution, thermionic and gaseous condition, and industrial applications. The latter stressing the importance of direct current in the application and general use of electrical energy.

Each chapter, with the exception of the first and last, is supplemented with practical problems dealing with the subject matter as contained in the chapter discussed.

Industrial Electricity and Wiring

By James A. Moyer, director of university extension, and John F. Wostrel, instructor in electrical engineering and supervisor in charge of industrial subjects, division of university extension, Massachusetts department of education. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Cloth binding, 469 pages, 281 illustrations. Price $2.75.

THE objective of the authors has been to provide a reference and text book for those who are seeking proficiency in the fields of electrical wiring and construction. In this endeavor they have succeeded admirably well.

The first two chapters are devoted to the study of the effects produced by electric currents, units of measurement, and simple applications. They are followed by chapters covering such topics as calculations of wiring systems, wiring methods and types, wiring old buildings, industrial and house appliances, electric generators and generator wiring, electric motors and motor wiring, transformers and their connections, out-door wiring, and so on. The methods and practices outlined are based on the requirements of the 1929 edition of the National Electrical Code, to which frequent references are made with appropriate explanations.

The subjects covered are presented in a simple and thoroughly practical way that will interest and help all who are engaged in any of the ordinary branches of electrical wiring.

Arithmetic of Electricity

By T. O'Conor Sloane. Published by The Norman W. Henley Publishing Company, 2 West 45th St., New York, N. Y. Clothing binding, 225 pages, illustrated. Price $1.50.

THIS little volume is a practical treatise on electrical calculations of all kinds, reduced to a series of simple rules and involving only ordinary arithmetic. Each rule is illustrated by one or more practical problems for which the detailed solution is given. The problems include applications of Ohm's law, resistance and conductance, alter-

nating and direct-current systems, work and energy, batteries, electromagnets, motors and generators, capacity, inductance, heating effects, and so on.

Mathematical calculations play an indispensable part in the study of electrical phenomena and their practical application in electrical engineering work. Those who are not equipped to handle calculations involving the use of algebra or higher mathematics, or who prefer to use the simpler, if longer, methods involving plain arithmetic, will find this work highly instructive and practical.

Storage Batteries

By George Wood Vinal, physicist, Bureau of Standards. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Second edition. Cloth, 416 pages, 160 illustrations, 61 tables. Price $5.

IN the preface to the first edition of this work it was pointed out that the primary purpose was to summarize the physical and chemical facts and theories about storage batteries, and describe their various applications. Included was a discussion of the properties of the materials used in constructing storage batteries, with a general description of the method of manufacture.

During the five years that have elapsed since the first edition was published, significant changes have taken place in the storage battery industry. Methods of manufacture have been changed in some respects, and additional information on battery performance has been made available. Also, storage batteries are finding new uses in heavy traction and on aircraft. Although the primary objective of this work has not been changed, the present edition represents a thorough revision of the entire book, many sections having been rewritten entirely or in part, and a new section on aircraft batteries added.

Any who are concerned with the application or care of storage batteries will find in this book a wealth of technical as well as practical information.

Materials of Engineering Construction

By Francis W. Roys, Professor of mechanical engineering, Worcester Polytechnic Institute, Worcester, Mass. Published by The Ronald Press Company, 15 East 26 St., New York, N. Y. Cloth, 306 pages, 167 illustrations, 17 tables. Price $4.

IN presenting this book the purpose of the author has been to give the student as well as the practical engineer a close acquaintance with the characteristics and properties of the more common and widely used materials of engineering. The first chapter is devoted to a discussion of the mechanics of materials—kinds of stress, types of loading, and so on. Succeeding chapters take up such materials as wood, lime and plaster, hydraulic cements and concretes, structural clay products, building stone, ferrous and non-ferrous metals and alloys, paints and varnishes, and so forth. No attempt has been made to produce a manual of engineering materials; hence, the treatment is brief and concise, but embraces the facts that should be known regarding the origin, properties, uses, and other important details in order to make intelligent selection and application possible. Numerous illustrations and tables of properties add much to the value of the text.

Those whose work involves the handling of any of the materials covered by this book will find it to be a handy reference that contains a great deal of practical, easy-to-use information.

Engineering Mechanics

By William E. Brooke and Hugh B. Wilcox, respectively Head of the Department, and Associate Professor of Mathematics and Mechanics, College of Engineering and Architecture, University of Minnesota. Published by Ginn and Company, 15 Ashburton Place, Boston, Mass. Cloth, 316 pages, illustrated. Price, $3.20.

THIS text has been written to give the reader or student a clear conception of the principles of mechanics and their mathematical treatment. In keeping with this aim, a concise discussion of units is given. The graphical methods of statics have been confined to one chapter. The catenary is treated in some detail, and its mechanical and geometrical properties indicated. A simplified treatment of moment of inertia is given, including the use of equimomental points. Kinematics is treated mainly by analytic methods, and includes the theory of moving axes for plane motion.

The energy equation is developed early and used frequently throughout dynamics.

The rectilinear motion of a particle under the action of a force which is a function of the distance, time, or velocity, serves to introduce some elementary differential equations.

Many illustrative examples have been fully solved in the text and more than the usual number of problems have been included.

The answers to all the problems are given to assist the reader in checking his own solutions.

In the preparation of this book, the viewpoint of the student with limited experience has been kept in mind. However, those of more mature years and experience who wish to review this subject, or increase their knowledge of it, will find the present volume well suited to their needs.

How About Your Regulators?

HAVE you had your oxy-acetylene welding regulators examined recently? Advertisements continually suggest to do this or that at least once a month or once a year in order to obtain the best service from the various products advertised. The same is true of regulators.

These devices are particularly subject to neglect although they may play a most important part in securing good welds. They must be in good working condition at all times in order to insure accurate regulation of both pressure and volume. They should be kept free from rust and dirt and protected from unnecessary shocks and jars. If it is necessary to move the cylinder to any distance it is generally advisable to remove the regulator before doing so.

Save your regulators.

Steel Pump Rods Act Like Rubber Bands

STEEL rods, ordinarily considered unelastic, have been found by Westinghouse engineers to stretch and contract as much as a foot or more (depending upon the total length) when used in deep oil-well pumping and, in many cases, act very much like rubber bands.

These rods, each about 20 ft. long, screwed together and lowered into a well, support at the lower end a pump which moves up and down from 6 to 30 times a minute to force oil to the surface.

Because of the starting, stopping, raising, and lowering of this string of rods and the long column of oil, each rod stretches a little. The top rod, of course, stretches the most because it supports the total weight, and the bottom rod the least.

Added together, the slight stretching in each 20-ft. link makes up the one foot or more total. Stranger still, because of the elasticity, the top link in the pumping chain may be going up while the bottom link is going down, and vice versa.

Wire cables used in drilling act the same way; when the heavy drill burrows its way a mile or more into the ground, the wire line may stretch 10 or 12 feet.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Forms for Periodic Inspection to Avoid Fire Hazards

BY using the inspection forms illustrated on this and the succeeding page, an ordinary layman, inexperienced in fire inspection can submit a suitable, usable, and intelligent report from which the safety, engineer, plant engineer or the fire-protection engineer can obtain all the information needed to watch for and eliminate plant fire hazards.

Self inspection, as practiced by the Sherwin-Williams Company with the use of the form shown hereon, eliminates the necessity for personal inspections in local branch plants, and points out hazards in existence which might possibly cause a fire.

Also, these reports are sent to the safety department where a careful analysis discloses any improper conditions that are present, enabling corrective measures to be taken promptly.

This report is made weekly.

(*Continued on the following page*)

SHERWIN-WILLIAMS SELF INSPECTIONS

BLANK USED FOR CHECKING FIRE SAFETY MAINTENANCE

Weekly Report of.....Plant

The safety of our property and the permanency of employment for those working on the premises depends upon the conditions maintained in the various departments and the efficiency of the fire appliances. Therefore, every employee, irrespective of position, can contribute materially to safeguarding our mutual interests.

Those in charge must see that the following conditions are actually investigated and correctly reported upon:

1. Are all departments clean and orderly?.....
2. Are all locations under benches, under stairs, etc., swept clean?.....
3. Are all closets and cupboards free of rubbish and clean?.....
4. Are sweepings, oily waste, rags, etc., promptly removed?.....
5. Are sufficient metal waste and trash cans provided?.....
6. Is there any rubbish or stock behind or in contact with steam pipes?.....
7. What are the conditions of your gas-soldering fires?.....
8. Are they safely set?.....
9. What is the general condition of lighting apparatus?.....
10. Are all electric drop lights and extensions in safe condition?.....
11. Are dressing rooms and lockers free of rubbish?.....
12. Is all clothing hung up?.....
13. When were lockers last inspected by you?.....
14. Are benzine and like volatiles kept outside of buildings at night?.....
15. Have you sufficient safety cans provided for same?.....
16. Are all fire doors in good repair and unobstructed so they can operate freely?.....
17. Are they all closed every night?.....
18. Are all fire shutters in good repair?.....
19. Are they all closed every night and holiday?.....
20. Are all hatches in working order?.....
21. Are pits or bottoms of shafts clean?.....
22. Are all watch-clock stations in service?.....
23. When did you last examine records?.....
24. Are all valves controlling water supplies to sprinkler system strapped open?.....
25. Is supply well or tank full and free from anything that would clog the outlet?.....
26. Has sufficient steam been run into elevated tank often enough to prevent freezing and is it clear of ice today?.....
27. Is any part of sprinkler system liable to freeze?.....
28. Are all alarms and gongs attached to sprinkler system in working condition?.....
29. Date last tested.....
30. Are any sprinkler heads corroded or painted or out of order?.....
31. Is there anything that would interfere with the proper distribution of water in event of any sprinklers being opened by fire?.....
32. Is there any place where stock or other material is piled closer than eighteen inches under or below the sprinkler heads?.....
33. Is fire pump and are other pumps that can be used for fire in working order?.....
34. When last tested?.....
35. Are all city, street and private hydrants in order?.....
36. When last tested?.....
37. Is hose at hydrants and on carts in good condition, and are inside stand-pipes all ready for use?.....
38. When last tested?.....
39. Are nozzles, spanners and wrenches in place?.....
40. Are fire-pails, casks and chemical extinguishers filled, in place and unobstructed?.....
41. When were extinguishers last recharged?.....
42. Who is held responsible for the proper maintenance of fire appliances? Give name and title .....
43. Date last drill of general fire brigade?.....
44. Date last drill of all separate units?.....
45. Are fire lanterns filled and ready for service?.....
46. Is special wire to fire department in good working order?.....

Friday noon, ...192.....,

Inspector.

Superintendent.

I hereby certify the above report is correct.....

INDUSTRIAL ENGINEERING'S DATA SHEETS

Forms for Periodic Inspection to Avoid Fire Hazards

(*Continued from the preceding page*)

ON this page, two forms, a long and a short, are reproduced, which are suggested for use by the Travelers Fire Insurance Company, as a means of obtaining pertinent information on plant conditions.

Both forms are labeled "Self Inspection Report Forms," and the period between inspections, according to the forms, is one month; however, in making up similar forms any period may be specified.

Without any inspection system, the condition of fire shutters, windows, fire doors, extinguishers, and other fire-protection equipment might not be regularly checked and found in good condition when needed.

Submitting these forms to the safety department as well not only improves the plant from a fire-protection angle but also makes it safer.

SELF INSPECTION REPORT FORM

THE TRAVELERS FIRE INSURANCE CO.
HARTFORD, CONN.
ENGINEERING AND INSPECTION DIVISION

MONTHLY REPORT To Be Sent Main Office

FIRM NAME_____ LOCATION_____
PERSON MAKING REPORT_____ DATE OF INSPECTION_____
NOTE: If any defect or unsatisfactory condition is found, explain its cause and steps being taken to correct it, in the space headed "CORRECTIONS AND REMARKS," on the last page of the report. In doing this, give the number of the question.

GENERAL CONDITIONS

CLEANLINESS AND ORDER
1. Are all portions of the plant free of dirt, rubbish or any unnecessary combustible material?_____
2. Any ordinary or special fire hazards not well protected_____

MAINTENANCE
3. Are watch clock records satisfactory?_____
4. Is there any stock congestion in the plant?_____

PROTECTION

FIRE DOORS AND SHUTTERS
5. Are fire doors and shutters closed at night and on Sundays and holidays?_____
6. Are any fire doors out of order or obstructed?_____

FIRST AID FIRE APPARATUS
7. Are water casks and pails full and well distributed?_____
8. Are all chemical extinguishers properly located and in good order?_____

SPRINKLER SYSTEM

GRAVITY TANK
9. Is tank full?_____ Is heater in working order?_____

PRESSURE TANK
10. Are proper air pressure and water level maintained?_____

FIRE PUMP
11. Is fire pump tested weekly?_____

DRY PIPE VALVE
12. Is proper air pressure maintained?_____ Was air pressure checked?_____

ALARMS
13. Are alarms in working order?_____ How often are they tested?_____

SPRINKLER CONTROL VALVES
14. Are all valves strapped or sealed open?_____ Turn easily?_____

MISCELLANEOUS
15. Are any sprinkler heads obstructed by stock, partitions, shelves, etc.?_____
16. Are cold weather valves open?_____ Properly tagged?_____
17. Have any sprinkler heads operated recently?_____

CORRECTIONS AND REMARKS

SELF INSPECTION REPORT FORM

THE TRAVELERS FIRE INSURANCE CO.
HARTFORD, CONN.
ENGINEERING AND INSPECTION DIVISION

MONTHLY REPORT To Be Sent Main Office

FIRM NAME_____ LOCATION_____
PERSON MAKING REPORT_____ DATE OF INSPECTION_____
NOTE: If defect or unsatisfactory condition is found, explain cause and steps being taken to correct it, in the space headed "CORRECTIONS AND REMARKS." Give the number of the question.

GENERAL CONDITIONS

CLEANLINESS AND ORDER
1. Are there accumulations of dirt or rubbish?_____
2. Are clothes lockers clean and in good repair?_____
3. Are approved waste cans used for storage of oily waste?_____ Are waste cans emptied daily?_____
4. Is shipping and packing room cleaned at closing time?_____
5. Is there unnecessary combustible material in the yard?_____
6. Are basements in all buildings clean?_____

MAINTENANCE
7. Are all portions of plant covered by watchman?_____
8. Are watch clock records satisfactory?_____
9. Are bearings properly oiled, clean and provided with drip pans?_____
10. Are there any broken window panes, plastering, flooring or other defects?_____
11. Is there any stock congestion in the plant?_____ Are any aisles obstructed?_____

HAZARDS

HEATING
12. Is there any woodwork or other combustible material too close to smokestacks, flues, furnaces, boilers, steampipes, etc.?_____
13. Is any combustible material dried on boilers or steampipes?_____
14. Is fuel supply safely arranged?_____

LIGHTING AND ELECTRICAL EQUIPMENT
15. Are there any open flame lights near combustible material?_____
16. Are there any broken fixtures or loose wires?_____
17. Are there any ordinary lamp cords looped over nails or pipes?_____
18. Are there any fuses bridged with wire?_____
19. Are motors clean and bearings well oiled?_____

MISCELLANEOUS
20. Are gasoline and other inflammable liquids properly stored and safely handled?_____
21. Are dry rooms clean and steam pipes free of combustible material?_____
22. Is there any violation of the "NO SMOKING" rule?_____

PROTECTION

FIRE DOORS, TRAPS, SHUTTERS, AND ESCAPES
23. Are any fire doors wedged open, obstructed or out of order?_____
24. Are automatic attachments on fire doors in order?_____
25. Are traps or doors on openings through floors in order and kept closed when not in use?_____
26. Are fire doors and shutters closed at night and on Sundays and holidays?_____
27. Are fire escapes obstructed, broken or out of order?_____

FIRST AID FIRE APPARATUS
28. Are chemical extinguishers properly charged and tagged?_____ Well distributed?_____
29. Are water casks and pails full?_____ Well distributed?_____ Sand pails full?_____
30. Is hose connected to standpipe and properly racked?_____ Hose in good condition?_____

SPRINKLER SYSTEM

CITY WATER CONNECTION
31. Are valves in connection to city main wide open?_____ What was pressure on gauge?_____
32. Has there been any interruption of city water supply?_____

GRAVITY TANK
33. Is tank full?_____ Are hoops and supports in good condition?_____
34. Is telltale or altitude gage in working order?_____ Is heater in working order?_____

PRESSURE TANK
35. Are proper air pressure and water level maintained?_____

FIRE PUMP
36. Is steam pressure of 50 lb. maintained for fire pump at all times?_____
37. Is suction clear of leaves or other obstruction?_____
38. Is priming tank full?_____ Is pump reservoir full?_____ Oil on hand in pump room?_____
39. Give results of last test below
(a) Time required to obtain water_____
(b) Was action smooth?_____
(c) Did steam trap operate?_____
(d) Were steam drips open?_____
(e) Were valves in steam connection to pump wide open?_____
(f) How many r.p.m. at 100-lb. water pressure with all outlets closed?_____

DRY PIPE VALVE
40. Is proper air pressure maintained?_____ Is dry pipe inclosure properly heated?_____
41. Are alarms in working order?_____ How often are they tested?_____
NOTE: Dry pipe systems should preferably be kept with air in pipes all year around.

ALARM VALVES (WES SYSTEM)
42. Are alarms in working order?_____ How often are they tested?_____

SPRINKLER CONTROL VALVES
43. Are all valves strapped or sealed open?_____ Turn easily?_____
44. Are any valves obstructed?_____ Post indicator valves oiled?_____

MISCELLANEOUS
45. Are any sprinkler heads obstructed by stock, partitions, shelves, etc.?_____
46. Are any sprinkler heads painted or corroded?_____
47. Are any sprinkler heads leaking, missing, or disconnected?_____
48. Are any sprinkler heads exposed to freezing that are controlled by cold weather valves?_____
49. Are cold weather valves open?_____ Properly tagged?_____
NOTE: Cold weather valves should be shut in cold weather and open in mild weather.
50. Have hydrants oiled and drained properly?_____
51. Have any sprinkler heads operated recently?_____

CORRECTIONS AND REMARKS

No. 18a

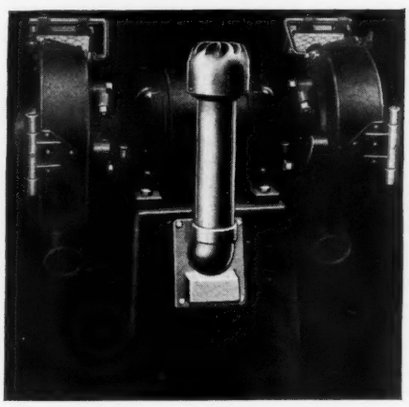
EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

Hammond Motor Air Cleaner

A MOTOR air cleaner is now standard equipment on all grinders and polishers of 3 hp. and larger sizes manufactured by the Hammond Machinery Builders, Inc., Kalamazoo, Mich. As shown in the illustration, the motor is totally inclosed and is cooled by the fan on the spindle.

All incoming air must pass through the centrifugal air cleaner which is directly connected through the pedestal to the cored end bell. The fan forces the clean, cool air over the motor windings and through the opposite end bell where it is discharged.

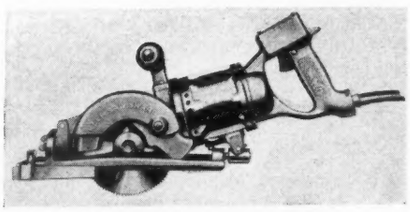


The manufacturers claim that this device assures a constant temperature of less than 40 deg. C. and completely excludes emery, metallic dust, chips, and other common causes of motor trouble.

Van Dorn Portable Electric Saws

THE Van Dorn Electric Tool Company, Cleveland, Ohio, announces, as additions to its line, three sizes of portable electric saws, the 6, 8, and 10 in.—the size representing the diameter of the circular saw blade that is used. They have been developed to increase production sawing of all kinds of wood and, with the use of an abrasive disc, to cut slate, marble, asbestos, transite, tile, porcelain, etc. The saws are driven by universal motors operating on both a.c. and d.c. circuits, and incorporate an automatic safety switch and an automatic telescopic guard.

The safety switch starts the saw when the trigger is pulled, but cuts off the current the instant the trigger is



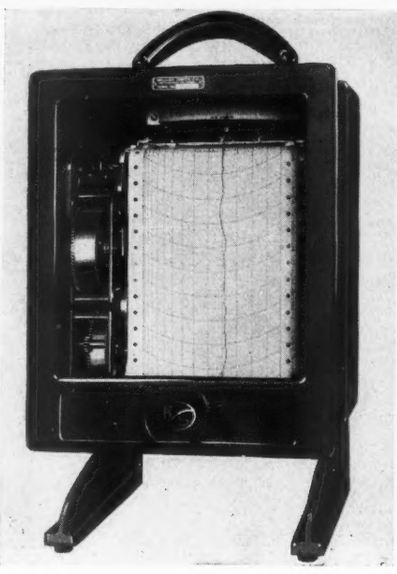
released, while the telescopic guard automatically opens as the saw enters the work and closes over the blade when the cut is finished, affording the utmost protection to the operator.

These saws are fully adjustable, having thumb-screw adjustments for regulation of depth of cut, width of cut, and a graduated adjustment for beveled cuts.

The depth of cut is adjustable. The maximum depth of the 6 in. size is 1¾ in., the 8 in. size 2½ in., and the 10 in. size 3½ in. Each saw is packed in a compact case for either shipping or carrying to the job.

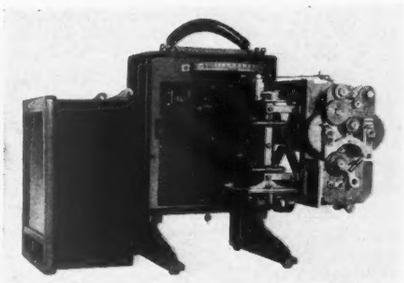
Roller-Smith Graphic Instruments

TWO additions to its line of graphic instruments, types AG and PG, have been announced by the Roller-Smith Company 233 Broadway, New York, N. Y. The instruments are made in the switchboard, wall, and portable models for direct and alternating current and as ammeters, voltmeters, single



and polyphase wattmeters, and power factor meters. The listings cover ranges required for most graphic instrument measurements, but special ranges and types can be supplied upon demand.

The instruments are built into a light, rigid, metal base, the cover of which may be instantly removed, making the insertion of new rolls, the filling of the ink well, and other adjustments convenient. To facilitate still further the making of adjustments which must be made when the instrument is in service, the clock and chart mechanisms and the electrical mechanism, are mounted on a common sub-base which is hinged on one side of the main base. This sub-base can be unlatched and swung outwards as shown in one of the accompanying illustrations. Both a.c. and



d.c. instruments are alike as regards case, base, and clock mechanisms; the sub-base being drilled differently to accommodate the various a.c. and d.c. movements.

The d.c. ammeter and voltmeter mechanism is of the high-torque d'Arsonval type of construction. The moving element bearings are extra large size Ceylon sapphire jewels. The a.c. movements are of the dynamometer type in which the field windings are mounted on a Bakelite form. Damping is secured by means of an aluminum disc passing between poles of powerful magnets, the principle used successfully for many years in watt-hour meters. Ammeters of the d.c. type are furnished with external shunts. All a.c. ammeters and wattmeters are of 5 amp. capacity and are designed for operation with standard current transformers.

Each instrument is accompanied by a special box containing a supply of ink, an extra pen point, a pen cleaner, and pen filler. A full set of instructions is also included.

Armature Air-Operated Coil Forming Machines

SOME of the outstanding features of the "Ace" air-operated coil formers introduced by the Armature Coil Equipment Company, Cleveland, Ohio, are: simplicity in setting up; strength to handle heavy, difficult coils; and ability

to form all slot angles and end curves without disassembling.

The air moves every part of the machine that completes the coil. This includes slot angles, coil-end curvatures, and the pull-down of the back carriage, thus obviating all hand operations other than inserting the loop and removing the finished coil. All moving parts that determine the size and shape of the coil are dialed and graduated for repetition work. A full set of stops handles all the mechanical movements. In addition, the main air control valve stops the machine automatically at the limit of the spread. By reversing the operating throttle when the completed loop is removed, all parts are moved back into position for the next loop.

Two sizes are available: No. 1, with a maximum loop length of 48 in. and a minimum of 10 in., and No. 2 with a maximum loop length of 60 in. and a minimum of 15 in. No. 1 has a coil spread of 15 in. and a coil holding jaw capacity of $\frac{5}{8}$x1$\frac{1}{4}$in. No. 2 has a coil spread limit of 27 in. and jaw holding capacity of $\frac{3}{4}$x1$\frac{1}{2}$ inches.

The machines require from 75 to 100 lb. of air. They are delivered complete including the shut-off valve.

Lincoln "Stainweld A" Electrode

AN electrode for welding the commonly called "18-8 Stainless Steels," and known as "Stainweld A," has been introduced by the Lincoln Electric Company, Cleveland, Ohio.

The advantages claimed by the manufacturer are that by its use, welds made can be of the same chemical content as the stainless steel itself, thus resulting in a dense ductile weld. This is accomplished by having the welding done in a protected atmosphere excluding the oxygen and eliminating oxidation of the weld metal. The rod itself is of the same chemical composition as the metal and is coated with a material which, in the intense heat of welding, forms a gaseous envelope around the arc. It is used with reversed polarity and permits the making of a weld that is just as impervious to corrosion as the metal it joins.

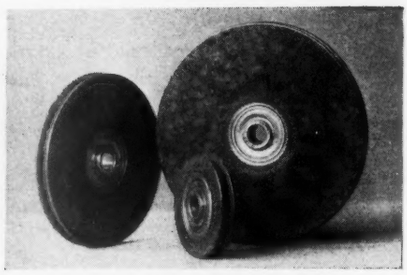
"Stainweld A" is obtainable in three sizes: $\frac{1}{8}$, 5/32, and 3/16-in., of the regulation 14-in. lengths, and can be used for horizontal, vertical, or overhead welding.

Westinghouse Micarta Pulley

AN improved Micarta pulley, supplementing its present line of Micarta products, has been announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. The pulley is equipped with high-grade ball bearings with close fitting dust shields. They are packed with grease at the factory.

A brass bushing with its outer surface knurled is anchored in the pulley in the molding operation. The inner diameter of the bushing is then reamed accurately to size, the bearing pressed in place, and the edges of the bushing finally swedged over to eliminate any possibility of the bearing becoming loose. This construction has the following advantages over that involving molding the bearing directly in the pulley:

The bearing can be packed with



grease before assembly of the dust shield; better alignment of the bearing can be secured; the pressed and swedged-in bearing will remain tight under all normal temperature and moisture conditions; the ball bearing is kept in its oiled paper carton until the pressing and swinging operation. Afterward, the completed pulley is immediately wrapped and packed for shipment.

Baldwin and Duckworth Chain Merge

ANNOUNCEMENT has been made of the merger of the Baldwin Chain & Manufacturing Company, Worcester, Mass., and the Duckworth Chain & Manufacturing Company, Springfield, Mass. The merged company will be known as the Baldwin-Duckworth Chain Corporation.

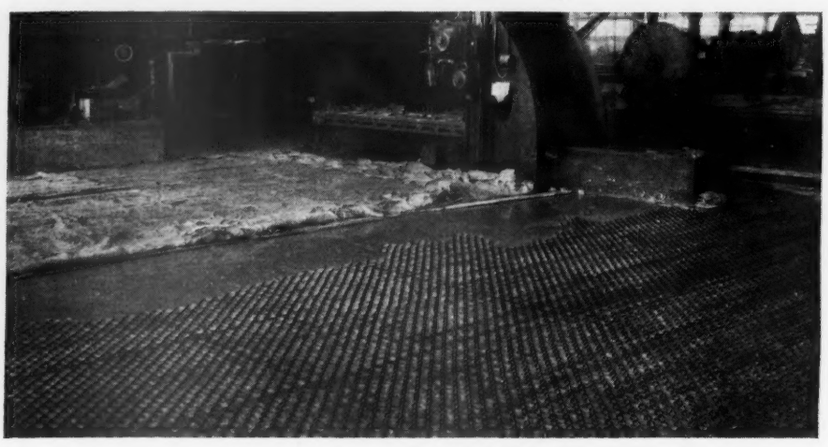
This merger brings together two old and well-known concerns in the chain manufacturing field. The former in the industrial and construction field with heavy-type chain, the latter with light industrial, cycle, and automotive chain. The present plants in Worcester and Springfield will be operated as separate divisions of the corporation.

Blaw-Knox Flooring Material

BLAW-KNOX Company, Pittsburgh, Pa., has patents pending on a type of steel armoring for concrete floors and pavements. This material is a strengthening and protecting mat of steel mesh which forms the wearing surface of the floor. The concrete, asphalt, or other paving material serves as a filler and binder for the steel web. The web is shown below.

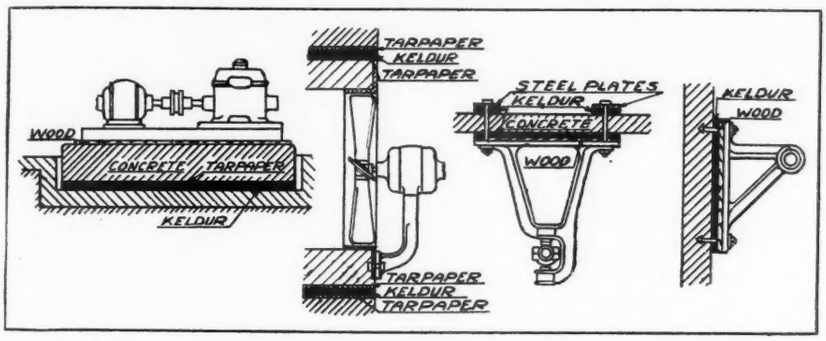
The material is made up of steel strips laced together on the job with small circular steel rods, placed at regular intervals in the web.

This mat is placed on edge and is of sufficient depth to distribute floor loads effectively and also to withstand shock and abrasion. The illustration shows the method laying a floor with this material.

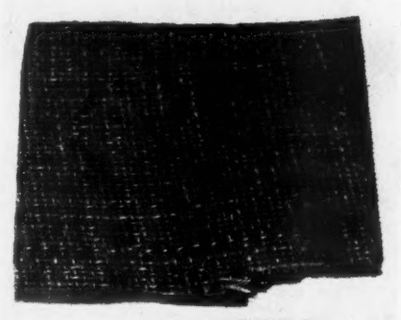


International Products' "Keldur" Vibration Insulating and Soundproofing Material

A RESILIENT, rubber-like material held between coarsely-woven jute cloth or burlap is being offered for vibration insulation purposes by the International Products Corporation, 425 Van Buren St., Milwaukee, Wis., under the trade name, "Keldur." Like rubber, it tends to deaden noise and check vibration, but it is not subject to deterioration in the presence of oil and will not harden, according to the manufacturer. It possesses durability against mechanical and chemical disturbances and will retain its elasticity almost indefinitely. The initial compression varies between 1 and 6 per cent.



This material can be used for either light or heavy equipment such as drop hammers, for motors and generators, presses, transmission equipment, prime movers, and all kinds of machinery where noise and vibration are to be held at a minimum. In certain applications like electrically driven household refrigerators, it is used for soundproofing purposes. It can also be used as a soundproofing material for doors and walls and as a floor covering over concrete.



Keldur comes in sheets 28x36 in. or 29½x40½ in., and in thicknesses of ¼, ⅜ and ¾ in. One sq. ft. of the ⅜-in. material weighs 3 1/3 lb. If one sheet is insufficient to cover the base of the machine, several sections can be laid side by side. If the vibrations are particularly severe, two thicknesses of Keldur should be applied.

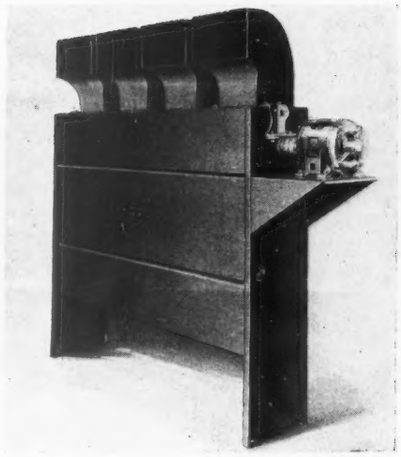
It is not necessary to insulate the entire base of the machine. Better practice is to cut the material into strips according to the frame of the machine allowing a little to project around the edge. Between the frame and Keldur, wooden strips 1¼ to 2 in. in thickness should be placed, preferably connected together in the form of a frame. If, for example, a motor is to be insulated, two planks are placed under the sliding track and the insulating material is tacked to the planks which are bolted to the floor, wall, or ceiling in the usual way. Thin metal plates can be substituted for the boards and this procedure would be desirable for appearance sake in the case of a built-in motor drive on a production machine.

When the machine is fastened through screws or bolts, the holes in the boards should be larger than the screw diameter to allow a slight amount of lateral freedom, disrupting rigid contact between the floor and machine frame. Before the machine is set up, the cut edges of Keldur should be lacquered or oiled to preserve it against dampness. When the material is used in walls or in concrete foundations, as in supporting heavy machines, it is inclosed in tarpaper to prevent mortar and dampness from penetrating.

Bishop & Babcock "Massachusetts" Unit Heaters

THE Massachusetts modified unit heater, in both floor and ceiling types, is being marketed by The Bishop & Babcock Sales Company, Massachusetts Blower Division, 4901 Hamilton Ave. N. E., Cleveland, Ohio. Type V, illustrated, is for floor use and Type C for ceiling suspension. Both units are similar in design and construction, except that in Type C the air flows through the units in a horizontal plane. This unit is also equipped with special discharge connections controlling the angle of air deflection downward, according to the needs of the particular installation.

Both heaters are equipped with a series of double-width double-inlet Massachusetts squirrel-cage fans mounted on a common shaft, the number of fans depending on the size of the unit. The sides of the fan casings, including the low-loss inlet cone and flanged stiffeners around the edges, are pressed from one piece of deep drawing steel. The scroll sheets are spot welded to the flanged casing sides.



Fafnir self-aligning pillow-block ball bearings, fitted for Alemite lubrication, are standard on all units. The end bearings are mounted on special cast-iron brackets provided with holes for crane hooks, to facilitate handling of the top assembly and complete heater.

All units are powered by standard ball-bearing motors mounted on live rubber cushions and secured to a structural steel bracket by bolts through rubber bushings and washers.

Appleton No-Thread Malleable Unilets

A LINE of No-Thread Malleable Unilets for use with Steeltubes has been announced by the Appleton Electric Company, 1701 Wellington Ave., Chicago, Ill. A contracting sleeve, developed by this company, grips the thin wall conduit firmly and is then secured to the Unilet in the regular manner. Three sizes are now available: ½, ¾ and 1 inch.

Steel & Tubes Vaporproof Couplings and Connectors

STEEL & TUBES, INC., 224 E. 131 St., Cleveland, Ohio, announces a line of vaporproof couplings and connectors for their product, Steeltubes electrical metallic tubing. These devices are for making a waterproof installation with Steeltubes, using threaded fittings. Improved bending hickeys are also available.

Freas Thermo-Electric Ovens

FREAS Thermo-Electric Company, 1206 S. Grove St., Irvington, N. J., introduces a series of controlled-heat electric ovens with horizontal-flow, forced-air circulation.

A motor-driven fan provides for agitation and propulsion of the air through air ducts which are located with inlets and outlets apportioned so as to provide uniform distribution of air throughout the operating chamber.

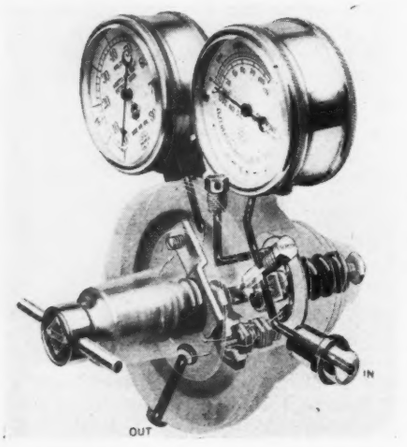
Construction is similar to other laboratory ovens in which, welded steel is used in the framework; double walls insulate the chamber against outside temperature fluctuations, thereby reducing heat losses and current consumption to a minimum. The heaters are of the low-temperature gradient type, controlled by a thermo-regulator of the differential linear expansion type, automatically maintaining a constant-temperature condition.

All ovens are equipped with shelf racks and are furnished with two perforated steel shelves. They are available in various standard sizes and temperature ranges.

Weldit Multi-Stage Regulator

TO maintain the pressure and volume of welding gases under constant control, a multi-stage regulator has been placed on the market by the Weldit Acetylene Company, 636 Bagley Ave., Detroit, Mich. Two separate regulators are placed in one body, the first or primary stage reducing the initial tank pressure of 2,000 lb. per sq. in. to a maximum of 200 lb. This regulating unit is built of strong parts, including a German silver diaphragm, a Monel metal pin, and a fiber seat. The second regulator or the secondary stage is connected to the first so that the 200-lb. pressure in the body of the first stage passes into the second stage. As the maximum pressure is never over 200 lb., the working parts in the second stage are more sensitive in operation.

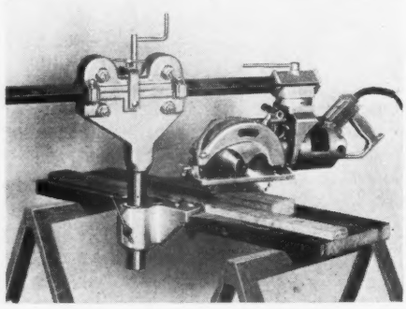
When the tank pressure is reduced below 200 lb., the first stage is cut out automatically, and the tank pressure is directly conveyed to the second stage. In this way it is possible to utilize practically all of the gas in the tank. Screens are installed to remove any foreign matter before the gas reaches the essential parts of the regulator.



Portable Radial Arm for Electric Hand Saw

A RADIAL arm which can be used to make a combination radial saw, table saw, or hand saw out of a portable electric hand saw has been announced by the Portable Power Tool Corporation, Warsaw, Ind. This device simplifies woodcutting, dadoing, dovetailing, mortising, and so on.

The arm is of special alloy steel, 47 in. long, and travels between two sets



of tapered roller bearings mounted in a frame which is attached to the workbench or table. The working height is adjustable from 0 to 8 in. An indicator shows the angle of the cut. The saw is attached to the arm by means of a bracket which is adjustable for bevel cutting.

Meriam Shock Absorber for Pressure Gages

A SHOCK absorber designed to avoid the difficulty of getting correct pressure or vacuum gage readings on pipe lines containing liquids, steam, etc., whose flow is pulsating, has been developed by the Meriam Company, Cleveland, Ohio.

This device consists of an air-tight steel chamber in which is a long spiral coil of tubing having a small bore. The remainder of the interior of the chamber is hollow and acts as a small air receiver for the gage mounted at

the top. This spiral coil is connected to the pipe line at one end, the other end opening directly into the chamber.

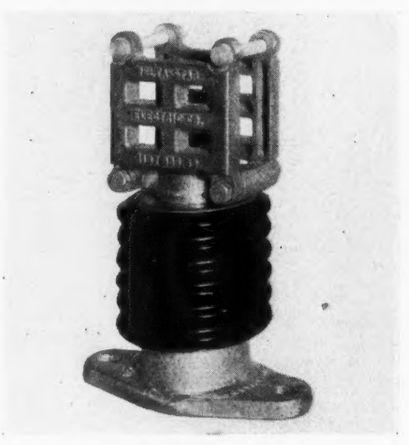
Pulsations in the pipe line are therefore largely dissipated by friction in passing through the long narrow bore of the tube; the pulsation remaining being absorbed by the cushioning effect of the air in the chamber itself. The gage is connected to a vertical tube which has its opening inside the chamber close to the bottom.

With the pulsations and shocks eliminated, the gage reads only the average pressure instead of registering the usual "jumpy" effect which is so hard to determine accurately. The length of the coiled feed pipe is proportioned to suit individual needs.

Delta-Star Bus Supports

HEAVY-DUTY bus supports of the center-bolt form, have been introduced by the Delta-Star Electric Company, 2400 Block Fulton St., Chicago, Ill. The 6-in. unit has metal inserts at each end threaded at the center for bolts by which top and bottom fittings are attached.

This single-bolt construction allows the fittings to be turned 360 deg. in a horizontal plane, permitting the bus to be run at any desired angle to the supporting structure.

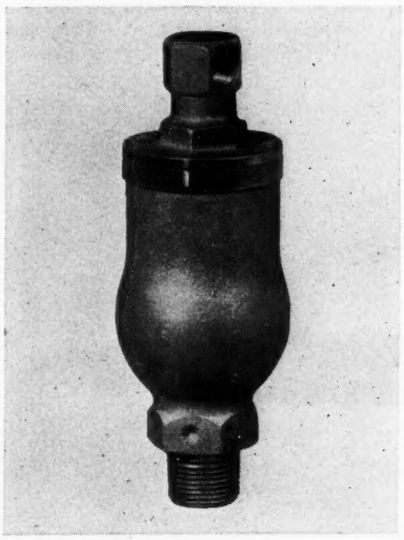


Automatic Primer Air Relief Valves

A LINE of air relief valves designed to automatically release accumulations of air from pipe lines, pumps, and various types of tanks or vessels is bemarketed by the Automatic Primer Company, 111 W. Washington St., Chicago, Illinois.

Apco valve No. 100 is for evacuating air from pump casings, pipe lines and vessels under pressures not exceeding 200 lb. per sq. in. Owing to the size of the valve chamber it serves as an air accumulator. The tapping is 1½ in., and its capacity ranges from 15 cu. ft. of air per min. under 10-lb. pressure, to 75 cu. ft. at 100-lb. pressure.

Valves Nos. 110, 120 and 130, are for use in piping systems where air to be vented may collect in large quantities

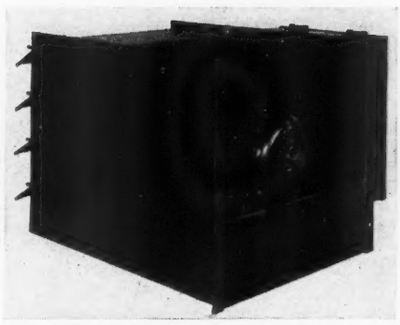


at pressures of 200 lb. or more. All three have 1½-in. tappings, whereas the capacities at 100-lb. pressures are: No. 110, 75 cu. ft. per min.; No. 120, 75 cu. ft. per min., and No. 130, 80 cu. ft. per min.

Valves Nos. 50, 60 and 70 are for use on piping systems, centrifugal pumps and various tanks or vessels. As ordinarily used they pass air in and out, but will close at once on liquids. By inserting a vacuum ball in the head of these valves, air will be passed out but not in. They are good for pressures up to 125 lb. per sq. in. The tapping sizes and capacities at 10-lb. pressure are: No. 50, ⅜ in., 3 c.f.m.; No. 60, ¾ in., 5 c.f.m.; No. 70, 1 in., 15 cubic feet per minute.

Hynes Electric Heating System

FAN circulation of warm air with automatic control is provided in the Hynes electric heating systems, manufactured by Lee P. Hynes, 240 Cherry St., Philadelphia, Pa. They are especially adapted for heating isolated power houses, substations, depots, storage rooms, garages, pump houses, and



industrial buildings where steam is not readily available.

All heating elements are arranged in a heating chamber so that air is forced over them by a motor-driven fan. Warmed air is delivered from the front or bottom of the heater through adjusting louvres.

The system of automatic condensation control reacts to both indoor temperatures and outdoor weather conditions, preventing condensation on walls and equipment owing to sudden weather changes.

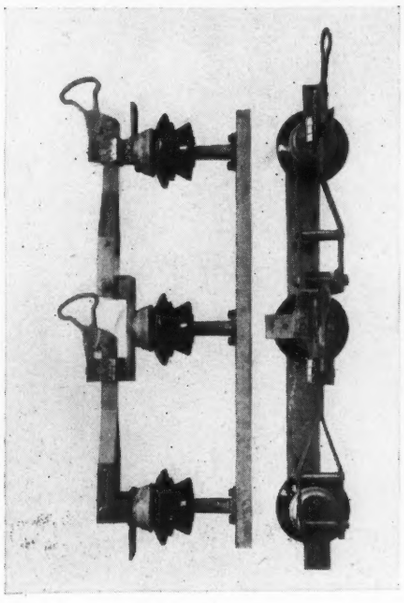
Heaters are made in several standard sizes, with ratings ranging from 5 to 50 kw., equivalent to 17,000 to 171,000 B.t.u. per hr. capacity. Larger units are available when required.

Champion Transfer-Type Disconnecting Switches

A LINE of double-blade, double-throw, transfer type disconnecting switches has been developed by the Champion Switch Company, Kenova, West Virginia.

They are furnished with double, self-aligning, full-floating contacts, truss-type blades, positive lock blade pry and a large eye for the operating stick.

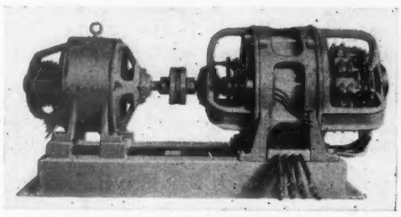
The switch shown is rated at 15,000 volts, 600 amp., but it can be supplied for various other ratings and with any of the standard makes of insulators.



Reliance Frequency Converters

FOR obtaining frequencies different from those furnished by the power company, the Reliance Electric & Engineering Company, Cleveland, Ohio, has designed and built special frequency converters for operation on either two-phase or three-phase current to provide an economical method of obtaining single-phase, two-phase or three-phase current at any low frequency. Frequencies as low as three to fifteen cycles can be obtained.

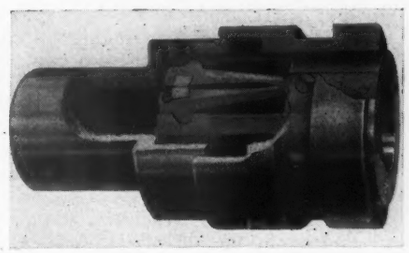
These frequency converters have been used to obtain variations in speeds with squirrel-cage induction mo-



tors and to get speeds which are either higher or lower than can be obtained from induction motors operating on a standard frequency.

Johnson Improved "Super Clutch"

AN improved clutch, known as the "Super-Clutch," has been brought out by the Carlyle Johnson Machine Company, Manchester, Conn. Formerly, carbon steel drop forged clutch fingers, also called clutch lever or tog-



gle levers, have been used, but to further increase the wearing qualities and reduce breakage to a minimum, chrome-nickel steel fingers have been substituted. The clutch has also been improved by installing a method of locking the adjusting screw, whereby the adjustment remains where it is set by the operator.

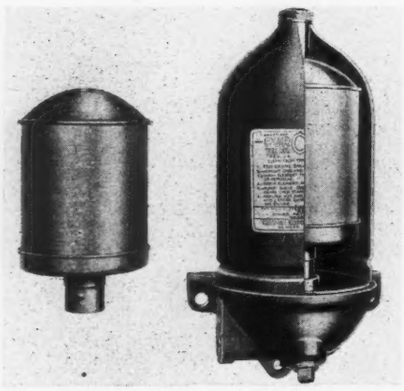
Another improvement is the replacement of tool-steel adjusting blocks with chrome-nickel steel adjusting blocks. The elimination of breakage from fire cracks in the hardening of these parts through the use of chrome-nickel steel adjusting blocks further increases the wearing qualities.

A fourth improvement is the Alemite system of lubrication, which has been applied in order that lubrication may be facilitated and oil-stained products prevented, and so that the interior of the clutch is thoroughly lubricated at all times.

Motor Improvements "Purolator" with Metal Filtering Element

ALTHOUGH made in sizes to meet every requirement, the "Purolator" with a metal filtering element is particularly suitable for application to Diesel and other types of heavy-duty industrial engines. It has been developed by Motor Improvements, Inc., 365 Frelinghuysen Ave., Newark, N. J. The principal features include: large area of filtering element within a small cubical measurement; reasonable cost; and the spacing of successive layers of metal which are accurate and uniform, to give the positive filtration and good flow. It may also be cleaned without any possibility of the parts being broken in the process.

To obtain the desired edge filtration without the use of successive layers of metal, it was necessary to construct a wedge-shaped metal ribbon, on one of

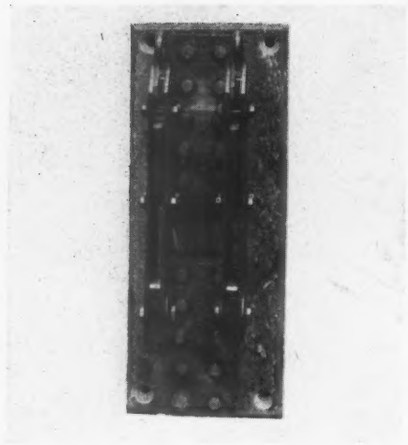


the flat surfaces of which are raised spots forming spacers at regular intervals. This ribbon forms the contact filtering element and the spots are 0.003 in. thick. Because of the wedge shape of the ribbon, the filtering slots are wider behind the filtering edge than at the filtering edge. By this means an accurate degree of filtration is obtained without clogging. Much of the dirt filtered from the oil slides down the element space or surface and falls into the bottom of the base, from whence it can be drained by removing the drain plug. The dirt that remains on the surface of the filtering element can be washed off easily.

Elements for the B-Type Purolators are made in two sizes, the B-15M and the B-1M. The former is 3⅞ in. in diameter and 4⅛ in. long, with 4,150 lineal inches of filtering slot 0.003 in. wide. The latter is 4⅛ in. in diameter and 4¼ in. long, with 5,550 lineal inches of filter slot.

Delta-Star Type TM-14 Form 2 Disconnecting Switch

AN improved line of low-voltage, high-ampere capacity disconnecting switches, known as Type TM-14 Form 2, has been developed by the Delta-Star Electric Company, 2400



Block, Fulton St., Chicago, Ill. They are double-blade switches with tongue-type contacts and a locking device with angular-type rings for ease of operation.

Contacts and terminal units are of high-conductivity copper and so designed that it is possible to match the required spacing of busbars necessary for limitation of temperature rise.

These improvements, together with liberal blade spacing and other design constants, keep the switch well within the allowable temperature rise. This line is rated 3,300 volts, 4,000 amp., and can be furnished with bases of marble, slate, or any of the other materials usually used for this purpose.

Breuer Portable Tank-Type Vacuum Cleaner

BREUER Electric Manufacturing Company, 852 Blackhawk St., Chicago, Ill., has recently placed on the market an industrial vacuum cleaner of the portable tank type. It was designed for heavy-duty work in cleaning machinery, motors, overhead pipes, girders, walls, floors, office rugs, as well as many other industrial applications.

Model 70 Tornado, employs an over-

size 2/5-hp. G. E. universal motor mounted on Norma ball bearings. The motor is mounted on a cast aluminum cover which fits over a steel tank finished in aluminum. Complete set of attachments is furnished to take care of any cleaning requirement.

A special feature is the convenience of removing the motor from the cover and using it as a portable blower.

Paragon-Revolute No. 3-E Automatic Blueprinting Machine

SEVERAL improvements in construction and operation have been made in the No. 3-E automatic blueprinting machine built by the Paragon-Revolute Corporation, 77 South St., Rochester, N. Y. Tracings are laid right side up on the continuous roll of blueprint paper, and are carried into the machine by an automatic roll feed. They pass upward and around a pyrex cylinder

which revolves, and are thus exposed to both sides of a bank of pyrex-globed arm lamps.

Tracings are held positively against the paper by a series of narrow endless belts, the tension on them being constant and controlled automatically, unless released by a treadle. Heat is removed by a centrifugal suction blower located at the end of the bank of arc lamps. A squirrel-cage motor furnishes the drive to the centrifugal blower.

Static is not generated on the cylinder of this machine because there is no relative movement between it and the originals. Therefore, the originals fall into the receiving tray without attention. By means of a variable-speed device, the speed of printing may be varied from 3 to 20 ft. per minute.

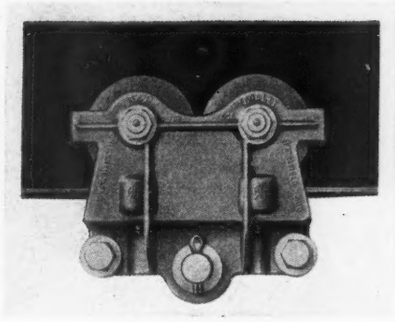
High-speed production can be obtained from the washing and potashing portion of the machine, the paper being under development over a distance of 10 ft. Both horizontal and vertical flood and spray washes are employed for the first water rinse. Potash is applied when the paper is in the hori-

zontal position. A dual reservoir permits the use of hypo. Another water rinse follows. The paper then passes through a baffle-type oven. Either gas or electricity may be used to furnish the heat. The automatic tensioning device prevents slack at all times. The machine is built in 42- and 54-in. capacities, and for d.c. or a.c. operation.

Robbins & Myers "Ace" Trolley

AN "Ace" trolley in plain and geared types ranging from ½- to 20-ton capacities is announced by the Hoist & Crane Division of Robbins & Myers, Inc., Springfield, Ohio.

In addition to conforming with all approved principles of trolley construction, the Ace trolley embodies a number of design features which make for



greater safety, utility, and durability. The following are outstanding: Heavy-ribbed cast-steel frame, capable of taking severe overload without distortion; chilled and crowned trolley wheels of the same analysis metal as standard chilled-iron car wheels; exclusive R&M combination of eight Timken and four Hyatt bearings providing not only for all radial and thrust loads, but also eliminating guide roller friction when the trolley is used on monorail beams; vertical guide rollers rotating on Hyatt dust-proof bearings bear against edge of I-beam flange on curves, permitting the use of the trolley on extremely small radius curves; safety lugs and wheel guards prevent trolley from falling in event of wheel or stud failure; smaller sizes of the trolley are adjustable to seven I-beam sizes; axle studs drilled for Zerk Alemite Lubrication; felt washers on both sides of trolley wheels retain lubricant and exclude dust.

Despatch Improved Indirect Gas-Fired Ovens

ONE of the principal improvements in the indirect, gas-fired ovens announced by the Despatch Oven Company, 622 Ninth St., Minneapolis, Minn., is the use of a square tube radiator which provides a greater radiating surface.

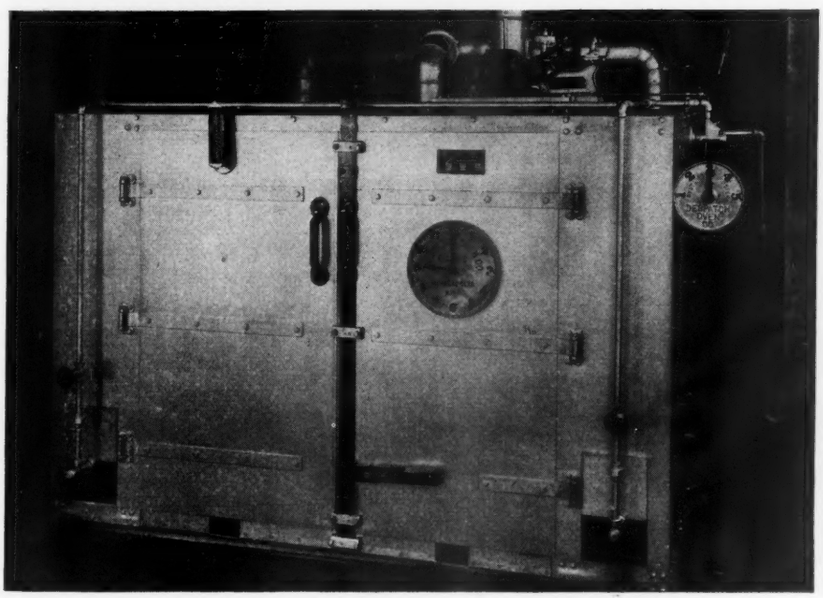
Atmospheric bar burners are mounted on the interior of the radiators which are provided with control and mixing valves to secure proper combustion of the gas being burned. To the top of the radiator is connected a small, electric, motor-driven exhaust fan which provides a constant draft through the radiator at all times, thus assuring a clean flame in any kind of weather.

A radiator is usually mounted on each side of the oven, so as to provide uniform heat distribution. A special ventilating system is provided which takes heavy vapors out of the oven at the bottom, and removes the lighter vapors at the top. By proper graduation of the ventilating ports in the ducts, proper circulation of the heated air is insured at all times.

No flame comes in contact with the volatile fumes which are given off during the baking process, therefore the danger of fire or explosion is reduced to a minimum.

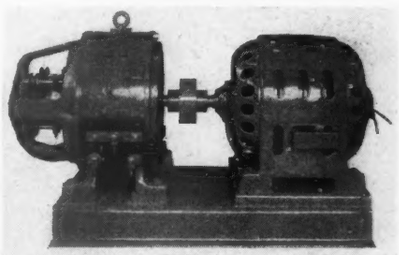
Heavy-duty construction, including 4-in. solidified rockwool insulation and special reinforcements, is also featured; the thickness of the insulation varying with the use to which the oven is to be put.

The heating system employed is controlled by a direct, throttling type, bi-metallic thermostat, but if more accurate and closer control is desired, a Bristol thermometer thermostat is furnished which operates in conjunction with a relay and electric valve in the gas supply line. This latter control system is furnished complete with necessary pilot light, remote-control switching arrangement, and fuse protection.



Reliance Adopts Steel Bases for Motor-Generator Sets

ELECTRICALLY welded bases of heavy steel plate for m. g. sets have been adopted by the Reliance Electric and Engineering Company, 1042 Ivanhoe Road, Cleveland, Ohio. Tops and ends of the welded bases are



completely closed so that no dirt can collect underneath.

Pads upon which the motor and generator rest are lined up horizontally and vertically by using the machines themselves as patterns for doing the aligning. Such shims as are needed are placed between the pads and the base. Horizontal alignment is maintained by the use of tight-fitting dowels. These are driven into the pads through the two diagonally opposite feet of each unit.

Sumet "Actinized" Bearing Bronze

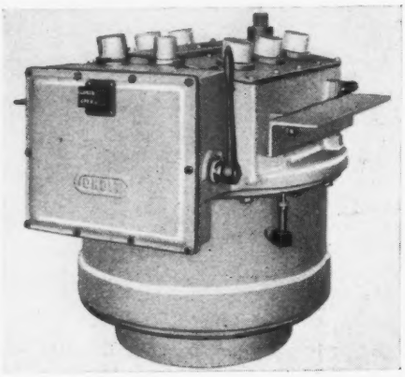
HIGH-LEAD bronze in which by a special "Actinizing" process all internal strains, growth, and distortion are said to have been eliminated has been introduced by the Sumet Corporation, Buffalo, N. Y. The material is available in cored and solid bars, drawn rods, and in castings of all sizes, and can be had in soft, medium, and hard grades.

This metal is claimed to have a true homogeneous structure, with the lead particles embedded in the matrix, thus combining the anti-frictional qualities of babbitt with the tensile strength of bronze.

Condit Oil Circuit Breaker

A MANHOLE oil circuit-breaker of moderate interrupting capacity for underground distribution service up to 7,500 volts has been placed on the market by the Condit Electrical Manufacturing Corporation, Boston, Mass. This unit, known as type M-10, is of sturdy water-tight construction throughout. A heavily-reinforced frame structure supports the operating mechanism, bushings, and current-carrying parts. In the upper part of the frame, space is provided for two bushing current transformers per pole in connection with which up to four trip coils can be furnished.

A cylindrical steel tank with a rounded, pressed bottom, lap welded to the tank sides, is drawn up tightly against the under side of the frame by a large number of closely spaced bolts. A flange on the frame overlaps the tank top. Suitable lining is provided as an additional safeguard to prevent the arc of an abnormal circuit interruption carrying to the tank wall. A ring is



welded to the tank bottom to facilitate floor mounting. Handles are welded to the tank sides to assist in raising and lowering. An oil gage is also furnished.

Lead-covered cables enter at the top through sleeves with wiped joints and terminate in porcelain insulators. There are no exposed current-carrying members above the oil line. The contacts consist of laminated brushes protected on opening by arcing contacts easily renewable and reversible.

Type M-10 is furnished manually operated, three-pole, single-throw, for 400, 600, and 800 amp. at 7,500 volts, non-automatic or full automatic (trip free), with an estimated interrupting capacity of 35,000 kilovolt amperes.

Unit Heater Grid Unit

A SUSPENDED-TYPE heater, known as the Grid Unit, has been placed on the market by the Unit Heater and Cooler Company, Wausau, Wis. The units are adapted for the circulation of cold water, and sodium or calcium brine, by direct connection to refrigerant pipe lines, as well as to steam lines, so that the unit can be used for cooling as well as heating.

Heating elements are composed of composite castings of close-grained

gray iron and aluminum alloy. They are of the cast, extended-surface, light-alloy type and are guaranteed for a working pressure of 250 lb. Manifolds are gray iron castings with lugs for attaching supporting rods. The casing or cabinet is made of pressed sheet steel attached to the manifold. Louvres are attached to the casing by means of special spring washers and bolts to permit adjustment to any desired position.

Grid Units are made in four models with capacities ranging from 76,000 to 382,000 B.t.u. per hr. at 5 lb. pressure.

Westinghouse "Safechange" Hanger

WESTINGHOUSE Electric and Manufacturing Company, East Pittsburgh, Pa., announces the Safechange hanger—a device which permits the easy and safe removal of industrial units for cleaning and relamping. When this hanger is used, the lighting unit cannot be removed or replaced while it is connected to the line.

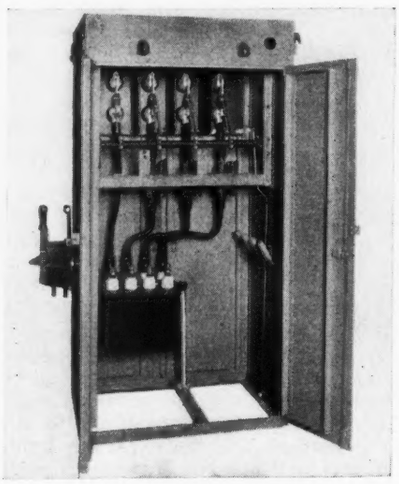
The illustration shows the construction of this device. The upper casting, which includes the hook, is threaded at the top for attachment to the conduit, and contains the receptacle for the plug used in connecting and disconnecting the lighting unit. The lower part, which is fastened to the lamp socket, consists of an eye through which the hook on the upper casting fits, and a housing for a porcelain bushing through which the cable to the plug passes.

This arrangement prevents the hook from being engaged or disengaged while the plug is in place. Therefore, the maintenance man cannot remove or replace a unit without first disconnecting it from the line.

Delta-Star Switch House

A LINE of switch houses for installation in customer's transformer vaults has been developed by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Illinois.

These houses are complete with mounting devices for any one of four connection diagrams, depending upon the number of feeders and type of service desired.

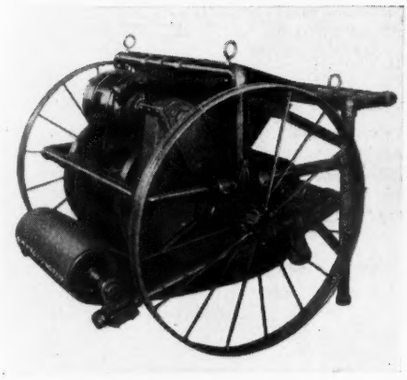


The gang-operated disconnects at the top are operated from a handle adjacent to the oil circuit breaker control handle. Mechanical interlocks are provided between the disconnects and oil breaker.

Stephens-Adamson Box Car Loader

CENTRIFUGAL force enables this heavy-duty box car loader, manufactured by Stephens-Adamson Manufacturing Company, Aurora, Ill., to throw bulk material such as sand, grain, stone, or fertilizer to the farthest corners of a box car. It is light enough to be handled by one man and has a capacity of 350 tons per hour—enough to fill four to seven cars per hour.

In operation, the machine is wheeled into the car to be loaded, the motor is started, and the material fed into the hopper. The stream thrown from the loader is directed to fill one end of the car, after which no further atten-



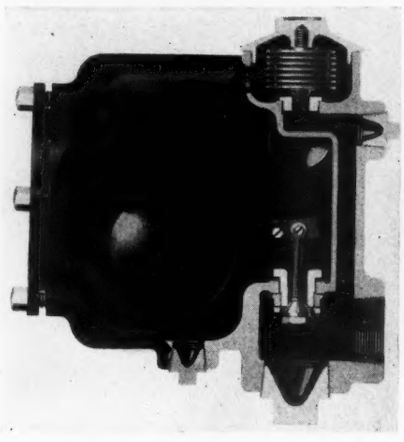
tion is needed except to swing the machine around to fill the other end.

The loader consists of a short endless conveyor belt, 30 in. wide, driven at a speed of 2,000 f.p.m. The carrying surface of the belt travels in a concave curve formed by two disks which touch the belt only at the outer edges. A loading hopper feeds the material between the disks where it meets the belt traveling in a downward direction. As the load follows around the curve, centrifugal force causes it to cling to the high-speed belt. Thus, in a travel of less than 2 ft. the material attains the speed of the belt and is thrown a distance of nearly 40 feet.

Driving power is furnished by a Westinghouse totally inclosed motor. All high-speed bearings are SKF double-row, self-aligning ball bearings with dust-tight grease seals and Alemite lubrication. As further protection against dust, the Morse chain drive is inclosed in an oil-tight housing.

Bishop & Babcock Blast Trap for Unit Heaters

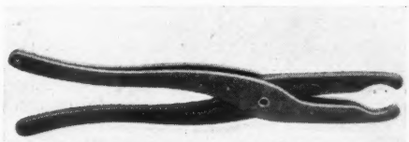
IN the blast trap introduced by the Bishop & Babcock Sales Company, 4910 Hamilton Ave., N. E., Cleveland, Ohio, and designed especially for unit heaters of the smaller sizes and for draining hot-blast coils, steam mains, and similar apparatus, the air relief is handled by the thermostatic member mounted in the upper part of the body. The water is controlled by a float-operated valve.



The valve, valve body, cover nut, and link are of high-quality steam brass. The float is of seamless copper and the air-valve thermostatic element is the standard multiflex bellows made by this company. Capacities range from 200 lb. an hour at ¼ lb. pressure to 800 lb. an hour at 5 lb. pressure.

Matthews Fuse Puller

A FUSE puller made of horn fiber of high dielectric strength, and known as No. 1158, has been introduced by the W. N. Matthews Corporation, 3722 Forest Park Blvd., St. Louis, Mo. This tool was designed primarily for removing cartridges from Matthews Fuswitches but also may be used for



removing and replacing cartridge-type fuses from panel boards, opening or closing fuse switches which have the cartridge mounted on the door, and many other uses where the operator must be protected.

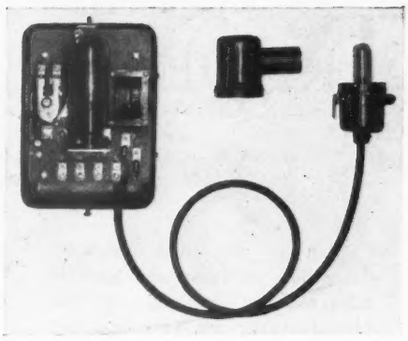
General Electric Photo-Electric Relay

THE interruption of a beam of light controls the operation of industrial machinery and other devices when utilizing the photo-electric relay announced by the General Electric Company, Schenectady, N. Y., as an addition to its standard line of control equipment. This relay is essentially a vacuum tube device and uses both the photo-electric tube and the pliotron.

Many industrial operations in which a change of light is involved can be controlled by the relay. In addition, many operations which can be arranged to cause a change of light can be so controlled. A machine, for example, which travels in a certain direction for a certain distance and is then stopped or reversed, is a typical application. When the traveling mechanism reaches its limit, it would interrupt a beam of light falling on the photo-electric tube and thus cause the control device to function.

Another example would be in counting items such as bags of material, boxes, etc., where mass production is involved. Vehicles passing a definite point can be counted in like manner.

A third application would be sorting packages according to size, shape, or reflecting power. Other examples would be stopping a paper machine when the paper breaks, aligning the paper on the rolls of the same machine, turning electric signs or signals on or off depending on the intensity of the outside



light, deflecting packages on conveyors, and operating bag-piling mechanisms.

The relay bears the G. E. designation CR-7505-A-1. It is designed for use on controlling an electric circuit in response to an increase or decrease in the amount of light falling on the photo-electric tube.

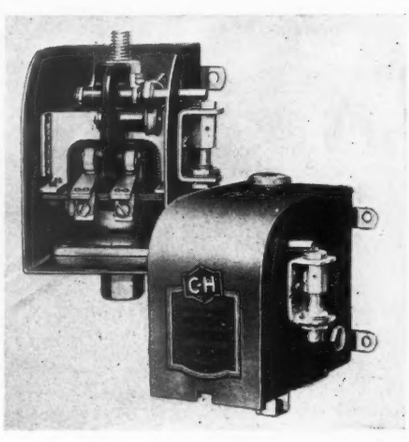
The standard electric supply for the relay is 110/120 volts, 60 cycles, a.c. The device may, however, be built on demand for other frequencies or voltages, and a similar device for operation where only direct current is available can be obtained.

Cutler-Hammer Bulletin 10006 Pressure Regulator

A SINGLE-POLE pressure regulator, designated Bulletin 10006, which can be used as a starting switch for motors up to 1 hp. on 230 volts a.c. or d.c., or as a pilot switch in the control circuit of automatic starters for larger motors, has been announced by Cutler-Hammer, Inc., 150 12th St., Milwaukee, Wis. The regulator closes the circuit at low pressure and opens it at high pressure. However, it can be adjusted to open the circuit at any pressure from 30 to 200 pounds.

Applications range over a wide field: for maintaining pressure on systems containing water and other fluids, also air, gas, and so on.

To withstand moist temperatures, the inclosing case is black japanned and the metal parts are cadmium plated. Double-break silver contacts prevent pitting and insure good contact. The diaphragm is of rubber. Conduit knockout holes in the case facilitate wiring.



TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog described, as given in these columns.

* * *

(116) PUMPS—"Centrifugal Pump Accessories," a collection of bulletins on centrifugal pump priming, with notes on the theory of suction lift, suction losses, and so on.—Barrett, Haentjens & Company, Hazleton, Pa.

(117) SAFETY—"Safety Advertising," sixth in a series of industrial safety leaflets designed to present the principles governing successful accident prevention work. Discusses the principles, form, appeal, and media to be used in this type of publicity, and is illustrated with photographs of effective bulletin board and blackboard displays.—Policyholders' Service Bureau, Metropolitan Life Insurance Company, One Madison Ave., New York, N. Y.

(118) ALLOY STEELS—Bulletin 15, data and applications, "Nickel-Chromium steels for high-temperature service valves and bolts."—The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

(119) LUMBER—A handbook of "Maximum Spans for Joists and Rafters" for the guidance of architects, engineers, contractors, and carpenters. Spans tables are given for joists of various sizes and spacing and with different live loads for plastered as well as unplastered ceilings, and for deflection limited to 1-360th in. as determined by bending. Copies may be had upon application.—National Lumber Manufacturers Association, 702 Transportation Building, Washington, D. C.

(120) CONDUIT—Booklet, "Answering Your Questions About Steeltubes."—Electrical Division, Steel and Tubes, Inc., Cleveland, Ohio.

(121) CHAIN—Bulletin 404, 32 pages on the proper use and care of welded chain, together with tables of sizes, weights, loads, and how to take measurements.—American Chain Company, Inc., Bridgeport, Conn.

(122) MOTORS—Leaflet 13-1, Types SC, SCN, and DSCH multi-speed, squirrel-cage, induction, polyphase motors, ½ to 150 hp.—Century Electric Company, 1806 Pine St., St. Louis, Mo.

(123) TERMINATORS—Bulletin 65-B, 8 pages, terminators for sealing ends of lead covered cables.—Delta-Star Electric Company, 2400 Block, Fulton St., Cnicago, Ill.

(124) WATER SUPPLY SYSTEMS—Bulletin 111, 20 pages, history and advantages of the pneumatic water system, several assembly and layout suggestions, engineering tables and specifications.—Chicago Pump Company, 2336 Wolfram St., Chicago, Ill.

(125) LIGHTNING ARRESTERS—Bulletin 278, 80 pages, Keystone Crystal Valve lightning arresters.—Electric Service Supplies Company, 50 Church St., New York, N. Y.

(126) SAFETY SWITCHES—Catalog 226, 72 pages; a complete line of porcelain-base safety switches, industrial safety switches, motor starting switches, range and commercial cooking switches, motor service switches and breakers, and overload protective devices.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(127) SPEED REDUCERS—Catalog 45, 80 pages, on herringbone and herringbone Magg speed reducers with tables, ratings, and installation photographs.—W. H. Jones Foundry & Machine Co., 4401-4451 W. Roosevelt Road, Chicago, Ill.

Coming Events

National Association of Foremen—Convention, June 6 and 7. Civic Auditorium and Chamber of Commerce, Toledo, Ohio. Harry J. Baumker, Convention Secretary, 316 10th St., Toledo, Ohio.

American Society of Mechanical Engineers—Semi-annual meeting of the Society, June 9 to 12, 1930. Hotel Book-Cadillac, Detroit, Mich.

National Association of Purchasing Agents—Fifteenth Annual Convention, Stevens Hotel, Chicago, Ill., June 16 to 19. G. A. Renard, Secretary-Treasurer, 11 Park Place, New York, N. Y.

National Electric Light Association—Annual Convention at Municipal Auditorium, San Francisco, Calif., June 16 to 20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

Association of Iron and Steel Electrical Engineers—Iron and Steel Exposition. Broadway Auditorium, Buffalo, N. Y., June 16 to 20 incl. John F. Kelly, Managing Director, Empire Building, Pittsburgh, Pa.

American Institute of Electrical Engineers—Annual Summer convention, June 23 to 27, Toronto, Ont. Annual Pacific Coast convention, Sept. 2 to 5, Portland, Ore.

National Safety Council—19th Annual Safety Congress, Sept. 29 to Oct. 4. Hotels William Penn and Fort Pitt, Pittsburgh, Pa.

Illuminating Engineering Society—Twenty-fourth annual convention, Hotel John Marshall, Richmond, Va., Oct. 7 to 10, 1930. Society headquarters, 29 West 39th St., New York City.

Fifth Midwest Engineering and Power Exposition—Coliseum, Chicago, Feb. 10 to 14, 1931. Managers, Midwest Engineering Exposition, Inc., 308 West Washington St., Chicago, Ill.

(128) FIRE APPLIANCES—Booklet, regulations of the National Board of Fire Underwriters for the installation, maintenance, and use of first-aid fire appliances.—National Fire Protection Association.

(129) BELT CONVEYORS—Catalog containing information on the design and application of Rex-Stearns Timken Idlers for all types of belt conveyors, together with allied and auxiliary equipment.—Chain Belt Company, Milwaukee, Wis.

(130) SHEAVES—Catalog 34, Pyott V-Belt pulleys and sheaves.—Pyott Foundry Co., 328 North Sangamon St., Chicago, Ill.

(131) LATHES—Catalog 91-A, 108 pages, 96 sizes and types of precision lathes with their tools and attachments.—South Bend Lathe Works, 426 E. Madison St., South Bend, Ind.

(132) LIGHTING EQUIPMENT—"Illumination by Silvray," catalog and handbook covering the application of Silvray lighting equipment to commercial, industrial, and decorative lighting applications.—Silvray Lighting, Incorporated, 53 W. 14th St., New York, N. Y.

(133) ALUMINUM—Booklet, "The Welding of Aluminum," gives specific instructions for the welding, by torch, of aluminum and its alloys, together with a brief description of the principles involved.—The Aluminum Company of America, Pittsburgh, Pa.

(134) SILENT CHAIN DRIVES—Bulletin 38, information on design, installation, and maintenance of Morse Silent Chain Drives, including tables of dimensions, pitches, and horsepower ratings.—Morse Chain Company, Ithaca, N. Y.

(135) AIR COMPRESSORS—Folder GEA-904C, single-stage centrifugal air compressors.—General Electric Company, Schenectady, N. Y.

(136) CIRCUIT BREAKERS—Leaflet DEA-1196, Type CN-1 oil circuit breakers.—General Electric Company, Schenectady, N. Y.

(137) LATHES—Bulletins 9 and 15 describe the 9 in. and 15 in. lathes respectively.—South Bend Lathe Works, 426 E. Madison St., South Bend, Ind.

(138) PUMPS—"Pump Guide No. 12," descriptions, tables, and suggestions covering pumps for many applications.—Chicago Pump Company, 2336 Wolfram St., Chicago, Ill.

(139) BEARINGS—Catalog 40, 36 pages, "Heliflex Bearings" helically wound straight-roller type.—The Roller Bearing Company of America, Trenton, N. J.

(140) GEARS—Catalog A54, standard stock gears.—The Charles Bond Company, 617 Arch St., Philadelphia, Pa.

(141) MOTORS—Bulletin 2015, Type TR self-start motor which develops torques up to 300 per cent of its normal rating on starting.—Triumph Electric Corporation, Cincinnati, Ohio.

(142) SILENT CHAIN—Data Book 125, 170 pages on design, construction, installation descriptions and photographs, instructions for determining chain length, and many dimension and reference tables.—Link-Belt Company, Indianapolis, Ind.